

Customer Engineering  
Manual of Instruction

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# IBM<sup>®</sup> Customer Engineering

## Manual of Instruction

**355/7300 Disk Storage**

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## PREFACE

This manual is intended primarily for use in training Customer Engineers in the construction and operation of the IBM 355, used with IBM 650 Systems, and the IBM 7300, used with IBM 7070 Systems. The material covers only the disk file and makes no specific references to the control unit or system; therefore, the manual may be used if this disk file is attached to any other system.

The material is presented in sections and each section expands on material contained in preceding sections. Page numbering is consecutive by section as is figure numbering. All figures are placed in the back of the manual.

The circuit description is written so that it may be applied to any arm in any box, although references in parentheses refer to Arm 0 of Box 0. Circuit descriptions refer to Wiring Diagram 440931-G unless otherwise noted.

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## 1.0.00 GENERAL INFORMATION

### 1.1.00 INTRODUCTION

#### 1.1.01 IBM 355 Model I and IBM 7300 Model I

The IBM 355 Model I is used with the IBM 650 Data Processing System. The disk files are large capacity storage devices which can store 6,000,000 decimal digits. The information is stored as 600,000 ten digit words plus a sign for each word. Alphabetic information and special characters may be stored by using a two digit code. Sixty words of information can be written in any location in a minimum of 135 ms, or a maximum of 185 ms. This information can be read in a minimum of 85 ms or a maximum of 135 ms. The seek time can vary from a minimum of 100 ms to a maximum of 850 ms.

The information is stored in a magnetic pattern having a coating of material similar to that on recording tape. The disks are twenty-four inches in diameter with recording surfaces on both sides. Fifty of these disks are used in one unit giving a total of one hundred recording surfaces.

The disks are mounted on a vertical shaft in the center of the unit (Figure 1-1). A one and one half horsepower motor drives the disks 1203 and 1232 revolutions per minute depending upon the source voltage.

Each disk has one hundred closed tracks on each surface. The outer track is one half inch from the edge of the disk and is numbered 00. The innermost track is numbered 99. The tracks are spaced at intervals of .050". Each track has a storage capacity of sixty words plus a sign position for each word. Thus, the total storage space per unit is 10,000 tracks of 60 words each or 600,000 words plus signs for each word.

Information on the disks is recorded and read by means of electromagnetic heads (Figure 3-4). Two of these heads are mounted on an arm which can position the heads properly for writing in, or reading from, the proper disk storage location. One head is above the disk and one head is below the disk. Because writing, reading, and processing within the arithmetic unit occur at a more rapid rate than the seeking operation, three access

arms (0, 1 and 2) are used in one unit. When programmed properly, the machine utilizes three access arms alternately, thus eliminating waiting for the completion of the previous seek operation before another operation can be initiated. When the arithmetic operations are brief in nature, it is possible to initiate seek instructions at such a rate as to have the three access arms in operation simultaneously.

Storage in the 355 and 7300 is in two out of five codes. The information is recorded serial by digit and serial by bit. Sixty words with sign are written or read in one operation. It is not possible to read or write less than sixty words with signs.

One to four disk storage units may be employed with each system. Thus a total of twelve access arms may be employed. Each access station has a numerical address which is used to select the proper seeking mechanism. Each seek, read, or write address contains six digits. One digit designates the unit. One digit designates the particular access station within that unit. Two digits designate the disk location and two digits designate the track on that disk.

#### 1.1.02 IBM 355 Model II and IBM 7300 Model II (Double Density File)

Each 355 Model II and 7300 Model II has 50 disks with 200 tracks on each face or a total of 20,000 addressable tracks. Each track has a capacity of sixty 10-digit words with signs for a total of 12,000,000 digits of storage. Alphabetic and special characters are represented by two-digit numbers; a maximum of 300 alphabetic and/or special characters can be stored on each track.

Each physical box is called a unit and each unit is composed of two sections known as modules. The units and modules are consecutively numbered; unit 0 has modules 0 and 1, unit 1 has modules 2 and 3, etc. The modules each have 100 tracks per disk surface for a total of 200 tracks per surface. The tracks of the odd numbered modules are interspersed with the tracks of the even numbered modules (Figure 1-2).

One to four units may be connected with each system to permit a maximum storage of 48,000,000

decimal digits. If a system contains a combination of Model I and Model II units, the Model II units must be assigned the low order Module numbers. A Model II unit cannot be attached to a Model I system.

## 1.2.00 PHYSICAL LAYOUT

### 1.2.01 Power Supply

The PECO supply, located at the right end of the frame, is divided into three levels. Level 1 contains fuses 22 to 42, the main line switch, and test point hubs for the three line phases and the filament supply. Level 2 has fuses 1 to 10, voltage controls, lights, and test hubs for the DC voltages. Level 3 has fuses 12 to 21 and the duo relays. The Auto-Manual Switch, Key Switch, Disk Power, Filament, and DC ON and OFF switches are located on this level, to the right of the duo relays.

The Sorensen Power Supply, is divided into four levels. Level 1 contains the -70 and +300S volt supplies, their adjustment potentiometers and fuses 1 - 5. Level 2 contains the -250, +150, and +300R volt supplies, their adjustment potentiometers, voltage indicating lights, and fuses 6 - 11. Level 3 contains the +48 volt supply, auto-manual switches, duo relays and fuses 12-21. Level 4 contains the 6.3 VAC supply, line and filament test hubs, main line switch and fuses 22 - 42.

The Arm and Disk Floating Power Supplies are located at the left end of the frame. The disk supply is to the left of the output cable shoe and the track supply is to the right of the input cable shoe (Figure 1-3).

### 1.2.02 Customer Engineering Panel

The CE Panel is located on the inside of the left end gate. The panel contains neons, test hubs, and switches for use by the Customer Engineer when servicing the file.

### 1.2.03 Access Stations

The three access stations are located at the left end of the frame. They are numbered 0, 1, 2 from back to front. Each station is a complete unit and may be removed from the file without

disabling the remaining station (s). Air is supplied through a quick disconnect coupling, motor power through a toggle switch and three prong plug, and arm circuitry is supplied through multi-plug connectors, to each station. Two read/write heads are at the end of each access arm, one to read the top and the other to read the bottom of the disks.

### 1.2.04 Electronic Components

The electronic pluggable units are located in the upper half of the gate on the left end of the file. The three tube pluggable units are mounted vertically. Pluggable unit layouts may be found in the back of the Wiring Diagram.

### 1.2.05 Relay Components

The wire contact relays are located below the electronic chassis. Some of the relays have gold points; they are identified with a yellow dot on the relay moulding. Individual points requiring gold wires are also identified with yellow dots. Mercury Wetted Relays are mounted above the three access stations.

### 1.2.06 Cable Connections

Two cable connectors are mounted on the bottom left end of the frame. The input connector (RS2) is located towards the front and the output connector (RS1) to the next file is located towards the back. The cable from the system is normally connected to RS2 of Box 0.

## 1.3.00 OPERATING CONTROLS

### 1.3.01 Master Circuit Breaker

A master circuit breaker is provided on the right side of the Level 1 power supply. When this circuit breaker is operated, all power is removed from the 355 simultaneously.

### 1.3.02 DC Off-On Switch

This switch, when turned off, removes all d-c voltages from the unit. One switch is located at the right end of the machine just to the right of the duo relays. A second switch is located on the C.E. Panel. The test outlet below the switch on

the panel has plus 48 volts when the switch is off.

#### 1.3.03 Manual-Automatic Switch

A two position switch marked Manual-Automatic (Man - Auto) is located to the right of the duo relays at the right end of the unit. This switch must be in the Automatic position to place file power under control of the system. When the unit is removed from the system, this switch must be in the Manual position.

#### 1.3.04 Key Switch

This switch is located to the right of the Manual-Automatic switch. When this switch is on (key is removed) it prevents writing in any location in the file. This is used by the customer as a file protection feature.

#### 1.3.05 Filament, Access, and Disk Power Switches

Just below the Man-Auto switch are six push-button switches. These switches are arranged in two vertical rows. The switches in the left row are "ON" switches and function is so marked on the top. To the right of each "ON" switch is an "OFF" switch. The function of these switches is marked above each switch.

When the Man-Auto switch (1.3.03) is in the Auto position, the six switches are inoperative. When the Man-Auto switch is in the Manual position the top pair of switches control the disk drive, the second pair control the access motors, and the bottom pair control the filament power. Disk drive must be depressed (ON) before the access motors can be started.

#### 1.3.06 Access Station Motor Switches

Three toggle switches on the bottom frame at the left end of the machine control the power to the drive motors in the three access stations. Each switch is located just below the drive motor with which it is associated.

#### 1.3.07 Arm Reset Indicators

Four indicator lights are mounted on the front of the machine. Starting from the left, the first

three indicators have yellow filters. The first one is marked Arm 0 and indicates while the first access arm is seeking, when it is off the system, when it fails to complete a mission, or does not reset. The second indicator is marked Arm 1 and the third indicator is marked Arm 2. Their action is the same as the first indicator and display the condition of the second and third access arms, respectively.

#### 1.3.08 DC-ON Light

The DC-ON indicator is to the right of the arm reset indicators. The light has a green filter and is marked DC-ON. The DC-ON indicator goes off when any DC voltage is lost in the file.

#### 1.3.09 DC Supply Indicators and Jacks

Across the top of Level 2 are indicators in a horizontal row. A tip jack is located just below each indicator. One indicator and one jack are associated with each of the DC supplies. The neon indicators glow when the supplies with which they are associated are on. The jacks provide a means of measuring the voltage for each of the supplies. I 1, 2, 3, 4, 5, 6 above the lamps designate indicator lamps. R 1, 2, 3, 4, 5 indicate output resistors. There are five voltage control potentiometers located on the second level of the power supply. They are labeled for adjustment of the +300S, +300R, +150, -70, and -250 voltage supplies.

#### 1.3.10 Air Pressure Guages

There are two air pressure indicators located in the lower portion of the right end of the machine. One indicates the pressure in the tank and should read between 80 and 100 pounds per square inch. The other indicates the pressure in the file and should read 55 pounds per square inch.



## 2.0.00 PRINCIPLES OF OPERATION

### 2.1.00 SEEK DISK (Figure 2-1)

The Seek Disk instruction causes the read/write head of the selected access arm to be placed opposite the track which is required for a following read or write instruction. The Program must place the seek address in an appropriate register prior to executing a seek instruction. The address consists of the six low-order digits in the register, and designates arm, box, disk, and track. Any information in the remaining positions will be ignored. While the access arm is seeking the new location, the system is released (restart) so that it may execute other operations.

Each access arm is driven by a motor and magnetic clutch system. Control voltages are impressed along the paths traveled by the arm and the carriage. (Sampling of these control voltages indicates the position of the arm and carriage.) The circuit design is such that both arm and carriage will seek ground potential.

In a typical operation, execution of the seek command will cause new address relays to pick, corresponding to the address previously designated by the program. The new address will then change the position of the ground applied to the control circuits, and cause the access station to move.

If the new address indicates a change in disk location, the arm must first be retracted to clear the disks. The carriage will then move vertically until a ground indication on the disk potentiometer indicates the proper location. As the carriage moves closer to its objective, the rate of travel is reduced so that it arrives at the proper disk position without overshooting. The carriage will then detent, allowing the arm to move horizontally until a ground on the track potentiometer indicates "position found".

### 2.2.00 READ DISK

The Read Disk address must be placed in storage prior to executing a read instruction. The address consists of six digits and designates arm, box, disk, and track.

When the system is placed in read status due to a Read Code, the address relays are checked for validity. The read circuitry is then conditioned to look for the all bits gap. This is a space of about 1.5 ms to 5.7 ms in length which contains all bits for all digit times except the last digit immediately before the record.

When the end of the gap is sensed, reading of the record commences. The first four digits are address digits and identify the track and disk location. These are known as locafier digits. The system compares the four locafier digits on the track with the address in the address relays. If errors are detected while checking the locafier digits the arm moves out, ten disks away from the address in the address relays, and back to the correct address. This recycle test occurs only on the first read or write operation after a seek operation.

Two oscillators are used on a read disk operation. Only one is on at a time but each time a bit is read from the track the one operating turns off and the other turns on. This arrangement is used to keep the phase clock pulse (PCP) in step with the bits recorded on the track.

While reading the locafier digits and sixty word record from the disk into the system core storage, each digit position is checked for validity. Each digit position must contain two and only two recorded bits. If the operation is completed without detecting any validity errors, the Read Mode latch is turned off, and the end of read/write is given. If an error is detected, however, the operation is repeated. If the error persists, the machine locks up in this operation and a manual reset must be performed.

### 2.3.00 WRITE DISK

On a write operation, as in a read operation, the locafier digits on the track are compared with the address relays to be sure the arm is positioned at the correct disk and track address.

On a write operation, when the locafier digits check correctly, the control unit changes to Write Gap. All bits are recorded until the write gap timer times out. Then, no bits are written for one digit time. Following the one digit blank, the

four locafier digits are rewritten followed by 60 words of information from the system core storage.

Writing on the track is in two of five codes. The information is recorded serially by digit and serially by bit. A six position ring is caused to advance every twelve microseconds and each period represents one of the following values:

| <u>Ring Bit</u> | <u>2/5 Code</u> |
|-----------------|-----------------|
| RB0             | Space - No Code |
| RB1             | Six Bit         |
| RB2             | Three Bit       |
| RB3             | Two Bit         |
| RB4             | One Bit         |
| RB5             | Zero Bit        |

The information is brought from the cores and switched with the ring digit representing each particular value. That is, the "six bits" from cores switch with Ring Bit 1, the "3 bits" from cores switch with Ring Bit 2 and so on. After the first digit has been written, two bits have been recorded on the disk and the cores read the next digit into the sense latches. The operation is repeated until sixty words have been written on the disk. The beginning and end of the record is indicated by recording bits at ring bit zero time in the first and last digits of the records.

The end of the sixty words of information overlap the write gap so that there is about two and one half words of gap when the operation is completed. This gap area indicates to the machine where the beginning of the record is located. This gap is not necessarily in the same radial location on any two tracks.

#### 2.4.00 WRITE CHECK

After the four locafier digits and the sixty words have been written, they are checked for validity and compared against the address relays and information in cores, respectively. If the information on the track does not agree with the information in the address relays or in the cores, the Compare Error latch is turned on. When the Compare Error latch is turned on, the 355 Compare Check latch is turned on. This latch remains on until the operation has been completed properly

or the manual reset key is depressed. The error condition is indicated on the panel by a neon lamp which is on when the File Compare Check latch is on. When the Compare Error latch is on, the write operation is repeated and the validity and comparing check made again. If the error condition persists, the machine is locked in this operation and the File Compare Check latch remains on. If the address and/or sixty words of information do not validity check correctly, the 355 Error latch is turned on. The File Error latch turns on the File Validity Check Error latch. This latch remains on until the operation has been completed properly or the manual reset key is depressed.

### 3.0.00 COMPONENTS

#### 3.1.00 DISK ASSEMBLY

##### 3.1.01 Disk Construction

The recording disks are twenty-four inches in diameter. They are fabricated from aluminum recording stock and have a 10.751" center hole. The degree of smoothness of finish and the hardness are achieved by use of a special process. The disks are prepared in halves, each half being etched, primed, and coated with the magnetic coating. After each half has been prepared and thoroughly tested, two halves are bonded to form a disk having two recording surfaces.

##### 3.1.02 Disk Assembly

The disks are mounted on a steel cylinder of 10.75" diameter (Figure 1-1). The cylinder is fitted at both ends with castings. At the center of each casting is a bearing. The disks, steel cylinder, and spacers revolve about a vertical hollow steel shaft which rises from the center of the base of the machine. For purposes of maximum service accessibility the upper end of the shaft is free of supporting members. Fifty recording disks are mounted on the steel cylinder at intervals of .400". Dummy disks are placed at the base of the stack and above the top recording disk to aid in reducing displacement of the top and bottom disks due to air currents produced by the high speed of rotation.

#### 3.2.00 ACCESS STATION

There are three identical stations in each file. Each station consists of a steel frame which acts as a mount for a drive motor; a clutch shaft containing two clutches, a tachometer, and a drive capstan, and a vertical way upon which a carriage travels vertically to any disk location (Figure 1-1). A linear resistance strip is fastened to the side of the way. The carriage contains: (1) an access arm which moves horizontally and carries the read/write heads, (2) the track and disk detents, and, (3) a linear resistance potentiometer.

##### 3.2.01 Drive

The drive consists of a one third horsepower

drive motor, two magnetic clutches, capstan and drive cable. Figure 3-1 is a schematic of the servo system used in an access station.

The two magnetic clutches are mounted on the clutch shaft (Figure 3-2). The clutch housings are driven by the cone pinion on the upper end of the drive motor shaft. The clutch housings revolve in opposite directions on the shaft. Inside each clutch housing is a disk which is pinned to the shaft. Magnetic particles fill the area between the housing and disk. A coil is mounted in, and rotates with, the clutch housing. The coil terminals are brought out to slip rings on the outer face of the housing. When an electric current is passed through the coil, the particles become magnetized and tend to solidify. This causes a bond between the disk and housing and results in rotation of the clutch shaft. The direction of rotation of the drive capstan is determined by the polarity of the input voltage to the servo-clutch amplifier. The operation of the servo-clutch amplifier is discussed in section 3.4.00.

A capstan is fastened to one end of the clutch shaft. Two stranded steel cables are wound on this capstan in opposite directions (Figure 3-2). One cable is fastened to the capstan, wound several times around it, and then up to the carriage, over a pulley to one end of the access arm. The second cable is fastened to the capstan, wound several times around it, opposite in direction to the first cable, up and over a pulley at the top of the access station, down to the carriage, under a pulley to the opposite end of the arm. The pulley at the top of the access station is mounted on a sliding block in a slot in the way to adjust tension in the drive cable.

With the drive cable threaded and secured as described, the following operations are possible: (1) move the arm in or out depending upon which clutch is energized when the disk detent is seated, (2) move the carriage up or down depending upon which clutch is energized when the disk detent is not engaged.

The direction of movement of the arm and/or carriage is determined by the direction of rotation of the capstan. The direction of rotation of the capstan is determined by which clutch is energized. The clutch which is energized is determined by the polarity of the input voltage to the servo-clutch amplifier.

### 3.2.02 Tachometer

The tachometer is mounted on the opposite end of the clutch shaft from the capstan (Figure 3-1). Whenever the clutch shaft turns, the tachometer generates a voltage to determine speed of movement and minimize overshoot of the arm or carriage.

### 3.2.03 Way

The way (Figure 3-1) serves four functions: (1) it serves as part of the frame for the access station; (2) it provides an accurate support on which the carriage can move up or down; (3) it provides a rigid mount for the linear resistance strip; and, (4) it provides by means of the detent holes an accurate positioning of the carriage opposite each disk.

The Linear Resistance strip is a long slender bar composed mainly of carbon and so constructed that it displays uniform resistivity for its entire length. Taps are brought out from this strip at intervals equal to disk spacing. The resistance between adjacent terminals is equal to within very close tolerances.

A wiper, mounted on the carriage, makes contact with the resistance strip. The wiper voltage is the input to the disk null amplifier and the servo-clutch amplifier.

### 3.2.04 Carriage

The carriage (Figure 3-3) acts as a mount for the access arm. It also contains two track detents, a disk detent, and a linear resistance potentiometer. The carriage moves up or down on a way which has a V-surface on one side. The opposite side from the V-surface is drilled at .4" intervals to accept the disk detent.

### 3.2.05 Arm

The access arm (Figure 1-1) mounts horizontally in the carriage and can be positioned at any one of the 100 tracks on a disk. The arm is split slightly more than half its length so that it straddles the disk. A read/write head is contained in both the upper and lower parts of the arm.

The arm is moved in or out by the drive cable

when the disk detent is seated. A rack on the access arm drives the linear resistance potentiometer, which indicates arm position.

### 3.2.06 Read/Write Head

The two read/write heads (Figure 3-4) are contained on the inner end of the access arm. An erase coil is also included in each read/write head assembly.

The heads are in a retracted position when the arm is seeking a location. When the arm is positioned at the location found, air pressure is applied to three pistons in each head. The head is driven toward the disk by the action of the air on the pistons and, although the head strikes the disk on initial impact, during reading and writing the head rides between .0002" and .0005" from the disk surface. After the original positioning, the head is prevented from making physical contact with the disk surface by a cushion of air between the head and the disk surface. The cushion is produced by air escaping through six orifices symmetrically located in the face of the read/write head.

Since a non-return-to-zero system is used for recording information on the track, the erase coil is mounted ahead of the write head to polarize the track in one direction before recording.

### 3.2.07 Detents

There are three detents on the Model I carriage: two track detents and a disk detent (Figure 3-5). The disk detent seats in holes drilled in the way. It is driven in and out by air pressure. It is driven in when the correct disk address is found. The detent is conically shaped on the end so that it will seat even though it is not in exact alignment with its hole.

One track detent is used for odd number track locations and the other detent is used for even number track locations. They are both driven in by air pressure and returned by spring tension. The selected track detent engages in a tooth on the access arm to firmly and accurately position the arm for reading or writing. Either track detent operates the track detent switch.

When an arm is fully retracted and neither the track nor the disk detents are engaged, the carriage is



free to move up or down. When the disk detent is engaged the carriage cannot move, but the access arm is free to move in or out. When the disk and one of the track detents are engaged, the access arm is in the position sought. It is not possible under normal operating conditions to have a track detent engaged when the disk detent is not engaged.

There is a fail-safe interlock to prevent the disk detent from being driven out until the arm is fully retracted. It likewise prevents the arm from being driven in while the disk detent is out (Figure 3-5).

### 3.2.08 Track Potentiometer

This is made of the same material used in the linear resistance strip mounted on the way. Because of space limitations it is mounted in circular form. The wiper revolves with the movement of the access arm so that almost the full length of the resistance is covered when the arm moves from track 00 to track 99.

### 3.3.00 AIR SYSTEM

The Remote Compressor Unit is designed to supply compressed air at about 100 psi to a maximum of four disk files. A 3HP motor is supplied with 208 or 230 volt 3 phase AC power which drives the compressor. The compressor unit can be operated under manual (local) control and then put under system control or it can be operated under complete remote control of the system. Compressed air is supplied to two receiver tanks (or a single receiver tank on later machines) in each file where it is metered to 55 psi.

The air is delivered from the compressor through an inter-cooler to a filter and water trap. From there it can go to a dump valve for exhaust purposes or through a check valve to the disk storage units. The check valve prevents air in the files from exhausting through the dump valve and from placing a back pressure on the compressor. The dump valve is open when the compressor is started to allow the compressor to reach running speed at atmospheric pressure. The valve then closes and remains closed until air pressure in the system reaches 100 psi. From this point on, the valve will close whenever the

pressure in the system drops to 80 psi and will open when the pressure builds up to 100 psi.

In each file, there are receiver tanks to store and supply air to its system. Each tank has a valve in the bottom to allow moisture to be blown out. The air passes through an adjustable reduction valve to supply the access mechanism with a constant pressure of 55 psi.

The plastic air supply line from the reduction valve connects to the three access stations. Quick-disconnect valves at each of the stations permit removal of the feed lines to the individual stations without interrupting the system.

A micro-switch, mounted on the air reduction valve, will cause the Fail-Safe Relay to be energized when there is sufficient air pressure. The relay must be up to allow reading and writing.

### 3.4.00 SERVO-CLUTCH (Figure 3-6)

The SC505 three-tube pluggable unit is used as the servo-clutch amplifier (Figure 3-7). There are three clutch amplifiers in each file, one for each access station. The amplifier has two branches, each having two triodes in cascade with a cathode follower output. The track or disk wiper voltage, controlled by a disk drive point, is fed to one branch (In-Down); the tachometer signal is fed to the other branch (Out-Up). The output of each branch controls three PW513's which operate the respective clutches.

Amplifier operation is conditioned by two potentiometers: bias and balance. These are adjusted to provide clutch current of 15 ma in each of the clutch coils when the amplifier input is grounded.

The tachometer signal is conditioned by two damping potentiometers, one for track drive and one for disk drive. The potentiometer used is determined by a disk drive point. These potentiometers provide a means of varying the amplitude of the tachometer signal which is fed to the amplifier to govern the servo speed. The Limit and Clutch Power relays must be energized before the output of the amplifier can be effective.

#### 3.4.01 No Signal - Input Grounded

The two input stages are biased so that there is some current flow with the input grounded. The first stage cathodes are at about the same potential and current flows to raise the cathode voltage to about the same as the most positive grid. With the first stage in each branch conducting equally, the second stage in each branch should be biased equally. This allows the output cathode follower in each branch to conduct. With the output at -5 volts, the PW513's controlled by each branch conduct to energize both the In-Down and Out-Up Clutches. With the amplifier correctly balanced, a minimum and equal current of about 15 ma flows through each clutch coil. This is not enough to cause appreciable drag.

#### 3.4.02 Positive Disk or Track Wiper Voltage

When a positive disk or track wiper voltage is fed to the amplifier, the first stage in the In-Down conducts. This raises the cathode potential of the first stage in each branch which cuts off the first stage in the Out-Up branch.

When the first stage in the In-Down branch conducts, the second stage in the same branch cuts off. This causes the output cathode follower to conduct and cause energization of the In-Down clutch coil.

With the first stage in the Out-Up branch cut off, the second stage conducts. When the second stage conducts, it cuts off the output cathode follower tube.

As the capstan and tachometer rotate, the tachometer generates a positive voltage. This is not sufficient to turn on the first stage of the Out-Up until the disk or track wiper voltage is equal to or less than the tachometer voltage. At this time, conduction in the In-Down branch decreases and the first stage of the Out-Up branch starts to conduct. This causes partial energization of the Out-Up clutch to act as a brake on the servo-mechanism.

#### 3.4.03 Negative Disk or Track Wiper Voltage

When a negative disk or track wiper voltage is fed to the amplifier, the first stage in the In-Down

branch is cut off. This lowers the cathode potential of the first stage in each branch which allows conduction in the first stage of the Out-Up branch.

As the capstan and tachometer rotate, the tachometer generates a negative voltage. This is not sufficient to cut off the first stage of the Out-Up branch until the disk or track wiper voltage is equal to or less than the tachometer voltage. At this time conduction in the first stage of the Out-Up branch decreases and the first stage of the In-Down branch starts to conduct. This causes partial energization of the In-Down clutch coil to act as a brake on the servo-mechanism. With proper damping adjustments the mechanism should stop without overshooting.

A varistor is connected from the track wiper and disk wiper inputs to ground. The resistance of this unit drops with an increase in applied potential. It is used to limit the amplitude of the applied signal to a practical range.

#### 3.5.00 DISK AND TRACK NULL

Seven double triodes are used for the track and disk null amplifiers (Figure 3-8). These are single tube pluggable units: two IN547's; two CF567's; two IN548's; and one CF568. The two amplifiers are identical in arrangement. One half of the CF 568 is the output cathode for the track null amplifier; the other half is the output for the disk null amplifier.

Track null adjust and disk null adjust potentiometers are used to adjust their respective amplifiers for maximum output with the input grounded. When the input voltage is within .4 to .5 volts, the output should be high enough to fire a CF512 which picks either the TN relay (Track Null output) or the DN relay (Disk Null output).

The operation of the track null and disk null amplifiers is identical. The track null amplifier is described below. The track null adjust pot determines the amount of conduction through the right side of the IN547 (Figure 3-8). This determines the cathode level for the IN547 and therefore the point at which the input voltage will initiate conduction.

With the track wiper voltage between -.5

and +.5 volts, the TN relay should pick. To accomplish this both halves of the IN 548 must be cut off, which means the left cathode must be above ground and the right grid must be below ground.

With the track wiper voltage between +0.5 and -0.5 volt the left side of the IN 547 will be in partial conduction. Its plate will be down a little and allow partial conduction in the left side of the CF567. The left plate of the CF567 will allow partial conduction in its right side. The pin 9 output will be at about -9 volts and the pin 10 output will be at about +9 volts. Since pin 9 is connected to the right grid and pin 10 to the left cathode of the IN548, both sides will be cut off and the plate output will be up. This allows conduction in the left side of the CF568 which raises the output sufficiently to fire the CF512 which picks the TN relay.

With a track wiper voltage more negative than -5 volts, the left side of the IN547 is approaching cut off. The plate output goes up and causes the left side of the CF567 to cut off. This raises the voltage on the grid divider input to the right side of the CF567 which causes it to conduct. With the right side conducting, the output at pins 9 and 10 goes up. Pin 10 coming up stops conduction in the left side of the IN548; pin 9 coming up causes conduction in the right side of the IN548. The plate output of the IN548 goes down and cuts off the left side of the CF568. This brings down the output to open the pick circuit to the TN relay.

With a track wiper voltage more than +.5 volts, the left side of the IN547 conducts. The plate output goes down. This allows conduction in the left side of the CF567. The plate output of the left side goes down, cutting off the right side of the CF567. The cathode follower output of the right side goes down and allows conduction in the left side of the IN548. This brings down the plate output which cuts off the left side of the CF568. This brings down the TN output, which opens the pick circuit to the TN relay.

### 3.6.00 READ CIRCUITS

The information is stored on the disk in a magnetic, nonreturn to zero, form. As the changes in flux pass under the read/write head,

they induce a voltage in it.

The peak to peak head signal strength may range from 22 MV at track 99 to 110 MV at track 00 because of the difference in linear velocity at the different tracks. The amplifier and shapers must operate with the wide range of signal amplitude and still discriminate against noise. This is accomplished by setting the DC bias of the grid of the CF571 at a level determined by the strength of the head signals being received. This is automatic clipping control.

There is one three-tube pluggable unit, a VA512, in each file (Sec. 44). This VA512 receives the head signal from the Te and Th edge connectors. The output of the VA512 is in the range of 5 to 23 volts (depending on the amplitude of the head signal) and supplied to the CF571. The grids of the second stage tubes are clip-clamped to ground by the IF534 on a write operation to prevent overdriving the amplifier.

The objective of automatic clipping control is to set the DC level (the level between signals) of the cathode of the CF571 at such a value that ground potential will be reached at about 50% of the negative swing of the amplified head signal. This places the clipping level close to half way between the negative peak of the signal and the negative peak of the noise. With one half of the negative swing of the signal below ground, the swing at the plate of the SA509 will obtain good shaping of the signal output from the SA510 (Figure 3-9).

The DC bias level at the grid of the CF571 sets the DC level at the cathode of the CF571 between signals. The negative swing of the AC signal starts from this current DC level. The magnitude of this minus swing is reduced by the voltage divider effect of the 10K and 47K resistances. This controls the minus swing at the grid of the IN552 (operating as a class A amplifier) which controls the positive swing at the cathode of the CF572 and determines the charge on the cathode RC combination. The condenser discharges through the parallel resistor and has a time constant of approximately 250 usec. This time allows the circuit to handle a 25% reduction in peak to peak signal strength of successive minus signals. Thus the DC bias level at the grid of the CF571 is set at a

level determined by the strength of the previous signal. The early head signals from the VA512 condition the clipping control circuits for the selected track and are used to locate gap end. Clipping control will continually be adjusted as the signal strength varies.

### 3.7.00 WRITE CIRCUITS

Each time the write buss is brought up, the direction of current flow through the read/write head must be reversed to record a bit on the track. The LT510 Binary Latch (Sec. 41) determines the direction of current flow through the head. Figure 3-10 shows the pluggable unit and its associated circuits.

The outputs at 7U and 8U switch with Write Gate at 7S to bring up either 7S3 and 7S4, or 7S5 and 7S6. The outputs of these switches provide two inputs to the write amplifiers so that current flow through the heads can be reversed on each write bus signal.

To have 8U output up, the following conditions must be present in the latch (Figure 8.4): Tubes 1A and 2A must be cut off; 3A must be conducting; 1B or 2B must be conducting; 3B must be cut off.

To have 7U output up, the following conditions must be present: Tubes 1B and 2B must be cut off; 3B must be conducting; 1A or 2A must be conducting; 3A must be cut off.

Assume a condition where the Write Gate is up and 8U is up. (8U was brought up by the last write buss signal.) Write gate and 8U output bring up 7S3 and 7S4 to bring up one output to the write amplifiers. This line stays up until the next write buss signal.

A latch back is provided as follows: 8U output makes 10S8 positive and with write buss down 11S8 is positive. This combination provides an up level to 10R3. With 10R3 up, 10R5 is down. This keeps tube 1A in cut off.

Pin 7U is kept down as follows: Tube 3A cathode up level causes tube 2B to conduct. The plate of 2B goes down and cuts off tube 3B. 3B cathode (7U output) goes down. The cathode of

3B is also tied to the grid of 2A to keep it cut off. With the above conditions present, 8U output remains up until the next write buss signal. When the next write buss signal comes through, 8U should go down and 7U should come up.

Write buss brings down 11R5 and 11R8. This brings down 11S5 and 11S8 which makes 10S7 negative. This makes 10R3 negative and causes tube 1A to conduct. This lowers the plate potential of tubes 1A and 2A, and cuts off 3A. 3A cathode goes down and cuts off tube 2B. 2B plate goes up provided tube 1B is also cut off. 1B conducted until the input capacitor charged when 8U was brought up. Because of the above, when 2B is cut off by a down level from 3A cathode 2B plate goes up to bring up the cathode of 3B (pin 7U output). 7U has a latchback similar to 8U output.

When the following write buss signal comes through, 7U goes down and 8U comes up. At the end of the previous write buss signal, the output of 11S8 and 7U switch at 10S to bring up 10R6. This brings down 10R8. This has no effect on 1B because it is already cut off. When 7U goes down, 10R6 goes negative. 10R8 goes up and turns on 1B. This brings the grid of 3B down to turn off 7U. 3B cathode going down cuts off 2A which brings up the grid of 3A. This brings up the cathode and 8U output.

The output of 7S3 and 4, or 7S5 and 6, is supplied to the grid of 7T (Sec. 42) whose output will raise the cathode of 6T and shut it off. The plate of 6T going positive will place cathode followers into conduction. The output of the cathode followers will raise the grids of the PW509 and cause the power tubes to conduct. The cathodes of the PW509 are connected to ground through one side of the R/WR head and the erase coil (Sec. 46) current always passes through the erase coil in the same direction.

#### 4.0.00 OPERATION CIRCUITS - MODEL I

##### 4.1.00 SEEK DISK STORAGE (Figure 4-1)

Seek Disk is one of the three basic operations of a disk storage file. This operation is required before a read or write operation involving disk storage. Seek codes should not be followed immediately in the program by a read or write instruction; the average search time is 550 ms. If a read or write operation is programmed immediately following a seek code, the entire system is interlocked until the access arm reaches the sought position. This would result in considerable loss of calculate time.

##### 4.1.01 Select Arm and File (Figure 4-2)

When the system receives a seek disk operation code, there must be information in storage to indicate the box, arm, disk, and track. The Control Unit analyzes the information and picks a relay driver to energize the access relays for the designated arm in the selected file (Sec. 23).

##### 4.1.02 Select Disk and Track

Further analysis of the information in storage picks relay drivers in the control unit to energize new disk and arm address relays through normally open access relay points (Sec. 19). Analysis of the operation code will energize a Start Reset relay (Sec. 5B). The Start Reset relay points will drop track null, the track detent solenoid, the previous address relays, and set up interlock circuits for the Control Unit. The new address relays are held through their pick coils by the relay drivers until the Start Reset relay drops. For a period of about 5 ms, while the old and the new address relays are all up, the validity relay will drop out. It will repick only if valid relays are left up after Start Reset picks. Start Reset will drop after the control unit verifies no errors.

##### 4.1.03 Servo Arm to Home Position

The track detent switch in the detent "out" position provides a circuit to energize the clutch power relay (Sec. 34A). Disk error voltage, developed when the new disk address relays were picked, caused disk null to drop. A normally closed disk null relay placed ground on the Home position of

the track potentiometer. The servo clutch amplifier causes the out-up clutch (Sec. 32A) to be energized and the arm moves out towards home position. When the track wiper reaches home, ground will be placed on the input to the track null amplifiers. The normally closed disk null relay point provides a circuit to pick home null instead of track null (Sec. 32B).

##### 4.1.04 Servo Arm to New Disk Location

When the home null relay is picked, one of its normally closed points transfers +48 volts from the disk detent IN solenoid to the disk detent out solenoid (Sec. 39B). As the detent moves out, the disk detent switch transfers and provides a circuit to energize the Disk Drive relay (Sec. 33A). The Disk Drive relay places the Servo clutch amplifier under control of the disk wiper. The arm moves up or down towards ground (dependent on what part of the linear resistance strip the address relays apply ground). When the disk wiper reaches ground, the disk null relay will pick (Sec. 33B).

##### 4.1.05 Servo the Arm to the New Track Location

The transfer of the disk null relay points drop home null and provide a circuit to the encapsulated resistor unit through the track address relays (Sec. 30A). When home null drops, a circuit is set up to drive the disk detent IN (Sec. 39B). Transferring the disk detent switch will drop disk drive. When disk drive drops, a circuit is provided to pick a smooth start relay and energize the in-down clutch by applying track error voltage to the servo clutch amplifier. The arm moves in towards ground. When the track wiper reaches ground, track null picks (Sec. 33B). The transferred track null relay points set up a circuit to energize a track detent solenoid. As the detent seats, the track detent switch transfers to drop the clutch power relay and pick the position found relay (Sec. 34A). Clutch power drops and opens the circuit to the clutches. Air is supplied to drive the read/write heads down to the disk when a normally open track null relay point closes.

##### 4.1.06 Recycle

Recycle occurs if the track detent fails to seat or if the locafier digits fail to check. If the track null point was in error to the extent the detent struck

on an arm tooth and failed to seat, the track detent switch normally open point would fail to close. In this situation, position found would fail to pick and the station would be inoperative. To prevent this failure from remaining, a track null relay normally open point supplies +48 volts to the grid of a CF512 (Sec. 34B). The RC network prevents the tube from going into conduction for 100 ms. If position found should pick during that time, -70 volts would be applied and prevent the tube from going into conduction at all. At the end of 100 ms, if position found has failed to pick, the CF512 will go into conduction and pick recycle relay 1. The recycle relay points will move the disk ground 10 disks away from the point specified by the address relays (Sec. 24-28). This will drop disk null and track null by placing error voltage on the null amplifiers. Recycle relay 1 will hold, and recycle relay 2 will pick, through the normally open recycle point and the normally closed null points (Sec. 33B). The arm servos to the new location but recycle relay 2 prevents energization of the track detent solenoids (Sec. 39A). However, disk null and track null pick and drop out the recycle relays. When the recycle relays drop, error voltage is again read by the disk and track wipers and the arm servos back to the location specified by the address relays.

#### 4.2.00 READ DISK STORAGE

Read disk is the operation permitting use by the system of the information stored in the file. Read disk will not cause an access arm to servo; therefore, read disk must be preceded by Seek Disk. In addition, the six digit address designating the location to be read must be in storage at the start of the read operation.

The 60 word record on each track is preceded by the all bit gap, a one digit gap, and four locafier digits. The record is transferred from the selected track to core storage after the address recorded on the track is found to agree with the address in the address relays. The time to read a complete track, assuming no error conditions, varies from 85 to 135 ms, depending upon the location of the beginning of the record when the start signal is received.

#### 4.2.01 Select Disk and Track Location

Upon development of the read code, information

from storage is analyzed to select Box-Head relay drivers in the control unit. The relay drivers energize access relays (24A) for the specified box and arm. The information in storage is further analyzed to select disk and track address relay drivers in the control unit. The address relay drivers energize the disk and track relay pick coils (Sec. 19 A, B) through normally open access relay points.

#### 4.2.02 Verify Disk and Track Address

The address relays energized during the previous seek operation are being held through start reset relay points (Sec. 20 A, B) and will not drop until start reset picks on a future seek operation. If the address relay pick coils energized (Sec. 19) are relays other than those being held (Sec. 20), the validity relay (Sec. 22 B) will drop. If the validity relay drops, an address error will be indicated.

#### 4.2.03 Verify Track Location

With no address error, there will be a circuit from the control unit to pick the head relays (Sec. 37) through address and access relay points and RS 2-85. The head relay hold coil (Sec. 38) will be energized, and the mercury wetted relay picked, by the control unit through RS 2-86 until the end of read. The transferred head relay point will pick bus relay 433 (Sec. 38B). R433-11 (Sec. 6 B) will signal the control unit to reset the access and address relay drivers. R 433-9 (Sec. 44A) supplies the amplified and shaped head signals to the control unit through RS 2-139. After reading the all bit area and the one digit blank gap on the first read after seek, the control unit will compare the locafier digits with the address relay output (Sec. 13-16). If the four locafier digits disagree with the location specified by the address relays, a signal from the control unit will pick the recycle relays through RS 2-122 (Sec. 33B). After the recycle operation (See 4.01.06) the system will attempt to read and verify the locafier digits. If the locafier digits check correctly, the locafier check control relay will pick through RS 2-76 (Sec. 35 A). The locafier check control relay will prevent the control unit from making any further locafier checks for that arm while the arm remains detented with position found energized.

#### 4.2.04 Read Record

When the locafier digits verify correctly, Word 00 Digit 0 position is read into cores followed by Word 00 Digit 1 position. All 60 words are read into cores. A space bit (Ring Bit 0) in Word 59 Digit 0 position will signal the control unit the last word of the record is being read. The 60 word record is checked for validity. If there is a missing or extra bit, the track will be read again. Successful reading of the record allows the control unit to end the read operations dropping out the bus and head relays.

#### 4.3.00 WRITE DISK STORAGE

Write disk is the operation in which information required for future use is stored in the file. As in read disk (4.2.00), the operation code will not cause an arm to servo and the six digit address designating the location to be written in must be in storage at the start of the operation.

The control unit first causes the locafier digits of the designated track to be read and compared against the address specified by the address relays. If the two addresses agree, the control unit switches to a write operation and, erasing the old record, a new all bit area is written, followed by a one digit space and the locafier digits. Sixty words of information from cores are then transferred to the track.

Following the writing of the information, the control unit switches back to a read status. The locafier digits and 60 words of information are read and checked for validity to complete the write operation.

#### 4.3.01 Select Disk and Track Location

Upon development of the write code, information from storage is analyzed to select matrix relay drivers in the control unit. Transfer of the matrix relays permit the picking of the access relays (Sec. 24A) for the specified box and arm. The information in storage is further analyzed to select disk and track address relay drivers in the control unit. The address relay drivers energize the disk and track relay pick coils (Sec. 19 A, B) through normally open access relay points.

#### 4.3.02 Verify Disk and Track Address

The address relays energized during the previous seek operation are being held through start reset relay points (Sec. 20 A, B) and will not drop until start reset picks on a future seek operation. If the address relay pick coils energized (Sec. 19) are relays other than those being held (Sec. 20) the validity relay (Sec. 22 B) will drop. If the validity relay drops, an address error will be indicated.

#### 4.3.03 Verify Track Location

With no address error, there will be a circuit from the control unit to pick the head relays (Sec. 37) through address and access relay points and RS2-85. The head relay hold coil (Sec. 38) will be energized, and the mercury wetted relay picked, by the control unit through RS2-86 until the end of write. The transferred head relay point will pick buss relay 433 (Sec. 38 B). R 433-11 (Sec. 6B) will signal the control unit to reset the access and address relay drivers. R 433-9 (Sec. 44A) supplies the amplified and shaped head signals to the control unit through RS 2-139.

After reading the all bit area and the one digit blank gap on the first write after seek, the control unit will compare the locafier digits with the address relay output (Sec. 13-16). If the four locafier digits disagree with the location specified by the address relays, a signal from the control unit will pick the recycle relays through RS2-122 (Sec. 33B). After the recycle operation (See 4.01.06) the system will attempt to read and verify the locafier digits. If the locafier digits check correctly, the locafier check control relay will pick through RS2-76 (Sec. 35A). The locafier check control relay will prevent the control unit from making any further locafier checks for that track while the arm remains detented with position found energized.

#### 4.3.04 Write Gap

When the locafier digits verify correctly, the control unit switches to a write gap operation and writes all bits for approximately 7.2 ms. The write bus is supplied to the binary latch (Sec. 41) through RS2-136, R433-3, and an inverter at 11R. Current passing through either side of the read/

write head passes through the erase coil to erase the old record. The one digit blank gap is written after the all bit area is written by bringing up write blank gap through RS2-137 and R433-5 (Sec. 41A). This holds up pin 8U of the binary latch and prevents any flipping of the latch.

#### 4.3.05 Write Locafier Digits

When write blank gap times out, the track and disk address specified by the address relays is sent to the control unit (Sec. 13-16). There, it is matched with locafier digit ring and causes write buss (Sec. 41A) to be brought up to rewrite the locafier digits.

#### 4.3.06 Write Record

Following writing of the locafier digits, the 60 word record from core storage will be written. Part of this information will erase and be written in the beginning of the all bit area. As a result, the all bit area will vary between 1.5 and 7.2 ms in length, depending on the track being used.

#### 4.3.07 Write Check

Upon completing the writing of the record, the control unit will change to a read status and read the locafier digits and record. All writing is checked for bit validity. In addition, the locafier digits are compared with the address relay output and the record is compared with the information in core storage. If there is a validity or comparing error, the control unit will repeat the write operation. Error free recording of the information will cause a read/write end operation in the control unit which will drop out the buss relays and head relays in the file.

#### 4.4.00 REMOTE COMPRESSOR

A remote air compressor is supplied with each installation to supply up to four files. On remote operation, the compressor must be turned on before power can be brought up in any of the files.

##### 4.4.01 Remote Operation (Figure 4-3)

With the local-remote switch on remote, R1 must be energized by the +48V AC sequence in. When

R1 transfers, a circuit is available from L3 of the 208 volt supply, through the local-remote switch on remote, R1 point, Compressor Motor Thermal, Blower Motor Thermal, overload point, Stop Key, Coil of C1, Emergency Off switch, to L2 of 208 volt supply.

A parallel circuit supplies the TD2 heater coil. After about 5 seconds, the TD2 n/c point will close and permit the +48 volt AC sequence in voltage to go to the first file. A third circuit in parallel to C1 will energize S1 through TD1 n/c. S1 opens the dump valve to permit the Compressor to get started at atmospheric pressure.

The C1-1, 2, and 3 points connect line voltage to the compressor and blower motors. C1-SSW-A closes a circuit to the TD1 heater. After about 5 seconds, the TD1 n/c point will open and drop S1 which will permit air pressure to build up in the compressor. When the air pressure builds up to 100 psi, P1 will close and repick S1. P1 will open when the air pressure drops to 80 psi and drop out S1. Thus, the dump valve will maintain air pressure between 80 psi and 100 psi.

##### 4.4.02 Manual Operation

With the local-remote switch on local, C1, S1, and the TD2 heater coil are energized through the start key instead of R1 n/o. The start key must be held until C1 SSW-B closes.

The transfer hold key, when depressed, will permit transferring the local-remote switch without loss of power to C1, S1, or TD2, while the compressor is running.



## 5.0.00 POWER SUPPLY

The power supply is located on the right end of the disk storage unit. It supplies the following voltages to the file circuits: -250 volts, -70 volts, +6.3 volts AC, +48 volts, +150 volts, +300 R volts, and +300 S volts. The +150 volts floating power supplies are located at the left end of the machine.

The files are turned on in sequence starting with box 0. The following sequence of turn on occurs in each box. The disk drive motor is turned on. After about sixty to sixty-five seconds, during which time the disks reach normal operating speed, the access motors are turned on, and one-half normal filament voltage is applied. One half normal filament voltage is applied for thirty seconds before applying full filament voltage. Thirty seconds later the DC regulator is connected to the line. This brings in the negative and positive voltages in that order. The same sequence then begins in Box 1.

Section references in the following description refer to Power Supply Wiring Diagram 490440 C.

### 5.1.00 AUTOMATIC OPERATION (Figure 5-1)

To start the files automatically, two signals are required from the control unit. The signal which is available at TB8-11 (3A) is the AC sequence in signal (available after voltages in the system are up). The signal available at TB8-13 (3A) is the AC sequence in signal (available after the air compressor is started). If the DC sequence in signal is lost, the positive and negative voltages are turned off but the filament voltage and the motors remain operative. If the AC sequence in signal is lost, all files in the system are turned off.

#### 5.1.01 AC Sequence On

When the AC sequence in line from the Control Unit comes up, it picks S1 (3A). S1-B completes the circuit to pick K1 (3A) and, through TD1-AL n/c, K1A (3A). K1-1, 2, and 3 points (1B) completes the circuit from the main line switch (1A) to the disk drive motor (file WD Sec. 4). K1A-1, 2, and 3 points (1A) short out the disk drive motor running fuses (fuses 29, 30, and 31) because of the high starting current. Auxiliary contact #2 on K1

(4A) completes a circuit from fuse 12 to the heater coil of TD1 (4A). Sixty to sixty-five seconds later TD1 heater point closes and TD1 picks (4A). TD1-BL points transfer to open the circuit to the TD1 heater coil and hold TD1. TD1-AL n/c (3A) opens to drop K1A, which inserts the running fuses in the disk drive motor circuit.

TD1-BU picks R2A (4A). R2A-AL (3A) picks K2. K2 points (1A) provide power to the access motors (file WD Sec. 3 and 4). R2A-AU picks R3A (4A) through normally closes K1A auxiliary contact #1.

R3A-AU (2B) and R3A-BL (2B) connect the filament regulator (Sec. 2B) and the blower motor (355 WD Sec. 4) to the line. At the instant voltage is applied to the filament regulator, the regulator output is zero. As the tube filaments warm up, this voltage will rise. After about 10 seconds, the voltage rises high enough to pick R1 (2B). R1-A points (4B) complete a circuit to the TD2 heater through TD2-BL n/c points.

TD2 (4B) picks through the TD2 heater point after a time delay of thirty seconds. TD2-BL points transfer to open the circuit to the TD2 heater, and hold TD2. TD2-BU picks R6 (4B). R6-A points transfer the filament regulator input to full voltage (2B). R6-B points complete a circuit to TD3 heater through R1-A and TD3-BL n/c (4B). Thirty seconds later TD3 heater point closes to pick TD3. TD3-BL points transfer to open the circuit to TD3 heater and hold TD3.

TD3-BU (3B) in conjunction with R5-A (4B) picks R4. (R5 picked with DC sequence from the control unit.) The AC sequence out signal is sent to the next file at the same time the circuit is completed to R4. R4 points (5B) connect the DC regulator (5B) to the line.

#### 5.1.02 DC Sequence On

When the DC sequence in signal (3A) from the control unit comes up, R5 (3A) picks. R5-A point (4B) sends a DC sequent out signal (+48 V) to the next file. (This picks R5 in that file. This continues until R5 in each file in the system is energized.)

When TD3 picks (see 5.1.01) R4 picks and an AC sequence out signal (3A) is sent to the next file. R4 points (5B) connect the DC regulator to the line.

The negative voltages are immediately available to the machine load; the positive voltages are connected to bleeder resistors. Relay V1 (6A) picks when the -250 volt supply comes up; relay V2 (6A) picks when the -70 volt supply comes up.

V1-A and V2-A (4A) in conjunction with R3A-AL, and R2A-AL, and R5-B, pick X2 and X3 (4A). X2-AU (6A) transfer the +300S volt supply from the bleeder resistor to the machine load. X2-AL (6A) transfers the +300R supply from the bleeder resistor to the machine load. X3-BU (2B) connects 6.3 V AC to the floating power supplies (355 WD Sec. 1). X3-AU and X3-AL (3B) connect the +48 volt supply to the machine load. X2-BU (6A) transfers the +150 volt supply from the bleeder resistor to the machine load.

#### 5.1.03 Loss of AC In Sequence Signal

This section describes turn off procedure when the file switches are set to automatic and the AC sequence in signal is lost.

When the AC sequence in signal (3A) is lost, S1 drops. S1-B opens to drop K1. K1 points (1B) open the disk drive motor circuits. K1 auxiliary contact #2 (4A) drops TD1. TD1-BU opens to drop R2A (4A). R2A-BL (3A) opens to drop K2. K2 points (1A) open the access motors circuits to the line. R2A-AU opens one hold circuit for R3A; however, it remains energized through X2-B (4A). R2A-AL opens to drop X2 and X3 which removes the positive voltages from the machine load and connects them to the bleeder resistors. X2-BL opens to drop R3A (4A). R3 points open to disconnect the filament regulator, which drops R1. R1-A opens to drop TD2 and TD3. TD2-BU opens to drop R6 (4B). TD3-BU opens to drop R4 (4B). R4 points open to disconnect the DC regulator from the line. This removes the negative voltages from the machine load and drops V1 and V2

#### 5.1.04 Loss of DC Sequence in Signal

If the DC sequence in signal (3A) is lost, when the switches are set to automatic, R5 (3A) drops. This opens the DC sequence out line to the next file which drops R5 in that file. This continues until R5 is down in all files beyond the first file to lose DC sequence. R5-A (4B) opens the circuit to R4. When R4 drops, it removes the DC regulator from

the line. The positive voltages drain off through R-C networks faster than the negative voltages. The disk drive, access and blower motors, and filament supply are not turned off if DC sequence in is lost.

### 5.2.00 MANUAL OPERATION

For manual operation, the Manual - Automatic switch must be on manual. This removes the file from the system. A file on "manual" does not affect the automatic operation of the remaining files in the system provided connecting cables are left in place and the main circuit breaker is left in the on position. The disk, access, and filament switches must be used to control the file.

#### 5.2.01 Disk On

Pressing the disk motor on switch (3A) picks K1 and K1A. K1 holds through K1 SSW-1, the disk motor off switch and the manual side of the manual - automatic switch (3A), K1A holds through TD1-AL n/c and the same circuit as K1. K1 SSW-2 (4A) provides a circuit to the TD1 heater coil. After sixty to sixty-five seconds, TD1-heater point closes to pick TD1. TD1-AL n/c points (3A) open the circuit to K1A. When K1A drops, the points open (1A) to insert the running fuses in the disk drive motor circuit.

The access switch (4A) is inoperative until TD1 picks and the filament switch (4A) is inoperative whenever K1A is energized. This prevents turning on the access motors or filament supply while the disks are building up to operating speed.

#### 5.2.02 Access On

After the disks are up to speed, pressing the access on switch (4A) picks R2A through TD1-BU. R2A holds through R2A-BU and access off switch (4A). R2A-BL (3A) completes a circuit to K2. The K2 points (1A) connect the access motors (file WD Sec. 3 and 4) to the line.

#### 5.2.03 Filament On

If desired the filament on switch may be depressed before the disk or access motors are started. This will bring power up without the motors running.

Pressing the filament on switch (4A) picks R3A through K1A SSW-1 n/c. R3A holds through R3A-BU. R3A-AU and R3A-BL (2B) connect the filament regulator and blower motor (file WD Sec. 4) to the line. After about 10 seconds, the regulator output rises high enough to pick R1 (2B). With R6 down, one half filament voltage is applied. R1-A (4B) connects voltage to the TD2 heater coil through TD2-BL n/c. Thirty seconds later, TD2 picks through TD2 heater point. TD2-BL points transfer to open the circuit to the TD2 heater, and hold TD2. TD2-BU completes the circuit to R6 (4B). R6-A points (2B) transfer the filament regulator to full voltage. R6-B completes the circuit to TD3 heater through R1-A and TD3-BL n/c (4B). Thirty seconds later, TD3 heater points close to pick TD3. TD3-BL points transfer to open the circuit to TD3 heater and hold TD3.

#### 5.2.04 DC On

When TD3 picks, TD3-BU (3B) completes a circuit to pick R4 (4B) provided the DC On-Off switch is on. R4 points (5B) connect the DC regulator to the line and the positive and negative voltages come up. The negative voltages are connected directly to the load; in addition they energize V1 and V2 (6A). The positive voltages are connected to bleeder networks until X2 and X3 pick through V1-A and V2-A (4A).

#### 5.2.05 DC Off

The DC switch in the off position will drop out X2 and X3 (4A) and R4 (4B). In addition, the switch will supply +48 volts to the convenience outlet (4B) on the side of the C.E. Panel (left gate-top). R4 points will drop the DC reactor (5, 6B). X3-AU and X3-AL (3B) will drop the +48 volts to the relay gate and X3-BU (2B) will drop the 6.3 volts to the floating power supply. The filament voltage and blower motor will remain up.

#### 5.2.06 Filament Off

Filament off switch (4A) will drop out R3-A. R3A-AL will drop out X2 and X3 (4A) and R3A-AU and R3A-BL will drop out the blower motors, filament reactor, and R1 (2B). R1-A will drop TD2 and TD3 (4B), causing all power to be lost except to the disk and access motors.

#### 5.2.07 Access Off

Depression of the access off switch (4A) will drop R2A. R2A-AL (3A) will drop K2 and the K2 points (1A) open the circuit to the access motors. Disk drive, filament, and DC remain on.

#### 5.2.08 Disk Off

Depression of the disk off switch 3A drops K1. K1 points (1B) open the circuit to the disk motor and K1 SSW-2 drops TD1 (4A). TD1-BU drops R2A and the access motor. Filaments and DC will remain on.

#### 5.2.09 Blown Fuse

A blown fuse (1B) will energize R17, R18, or R19. Either of these relays "A" points will drop out R11 (4B). R11A n/c energizes HR5 (4A). HR5 will remain energized and the fuse lamp lit until the Reset Key is depressed. HR5-BL will drop out K1 (3A). K1 points will remove power from the disk motor (1B) and drop TD1 (4A). TD1-BU will drop R2A (4A) and R2A-AL will drop K2, removing power from the access motors (1A). R2A-BU will drop X2 and X3 (4A), X2 and X3 points will drop the plus DC voltages and R3-A (4A). When the filament drops (2B), R1 will drop. R1-A (4B) will drop out TD2 and TD3 to complete power sequencing down.

## 6.0.00 MODEL 2 DISK STORAGE FILE

The 12 million character disk storage file is similar to the Model 1 file. However, it has twice the number of tracks per disk to provide double the storage capacity.

### 6.1.00 MECHANICAL CHANGES

Three mechanical changes have been made to the stations to obtain the increased number of tracks. The read/write head has been changed by decreasing the thickness of the laminated core. Two track detents have been added making a total of four. Ten teeth have been added to the gear track to accommodate the additional track detents.

### 6.2.00 FUNCTIONAL CHANGES

The Model 2 file is equivalent, in storage capacity, to two Model 1 files. Each physical box is called a unit and each unit is composed of two sections called modules. The units are numbered 0, 1, 2, and 3 and the modules are addressed 0 through 7. Modules 0 and 1 are in unit 0 and modules 6 and 7 would be in unit 3. Each module has 100 tracks per disk surface making a total of 200 tracks per disk surface. The tracks of each module are interspersed so that the outside track is track 00 of the even-numbered module and the inside track is track 99 of the odd-numbered module.

The Model 2 file has necessitated a change in the addressing of disk storage. Five digits of the address still indicate the arm, track, and disk locations, but the sixth digit indicates module, rather than box. The processing of the address through the computer and disk file remains the same as in Model 1 systems.

### 6.3.00 MODEL 2 CIRCUIT REVISIONS

All references in the following section refer to WD134309.

#### 6.3.01 Module Relay Pick

The module relays (Sec. 25A) pick at the same time as the access relays. The module relays hold (Sec. 26A) through their own point and a Start Reset normally closed point. The normally energized

manual reset point will pick the even module relay on a manual reset.

#### 6.3.02 Track Selection

A change has been made in the encapsulated resistor network (Sec. 31A, B) to accommodate the selection of a set of tracks dispersed between another set of tracks. By replacing a 1K resistor with two 500 ohm resistors on one end and adding a 500 ohm resistor on the other end, it is possible to switch the network voltage in steps equivalent to half that of the Model 1 file. This switching of the 500 ohm resistors provides the additional voltage drop variations necessary to control the arm to select 200 tracks per disk surface instead of 100 tracks.

When the even module relay is picked, the 500 ohm resistor in the low order end of the network will be shorted out. This will cause the voltage to shift downward and move the arm to select one of alternate tracks starting with the first outside track. Selection of the odd module will short but one of the 500 ohm resistors in the high end of the network and move the arm inward to select one of the alternate tracks starting with the second outside track.

#### 6.3.03 Track Identification

The locafier digits are increased to 5 digits to include module along with disk and track number. Within each file, the even numbered module (0, 2, 4, 6) is designated as 0 (1 and 2 bit) and the odd numbered module is designated as 1 (0 and 1 bit). For address and locafier checking purposes the module information is sent to the control unit whenever the buss and head relays are up (Sec. 17).

#### 6.3.04 Address Validity

The track address validity circuit (Sec. 24A) checks to insure that one and only one module relay is energized. If both or neither are energized, validity relay 74 (Sec. 24B) will fail to pick.

#### 6.3.05 Track Detents

Track detent solenoids 1 or 3 will be energized for odd module track locations through even module relay normally closed points (Sec. 41A). Solenoids

2 or 4 will be energized through the normally open points for even module track locations. The buss relay lights are replaced with the added track de- tent lights on the CE Panel.

#### 6.3.06 Head Signal Amplification

The gain of the VA513 voltage amplifier (Sec. 46B) is increased to compensate for the lower head signals produced by the new read/write head. This gain is achieved by decreasing the cathode de- generation in the second and third stages of this unit.

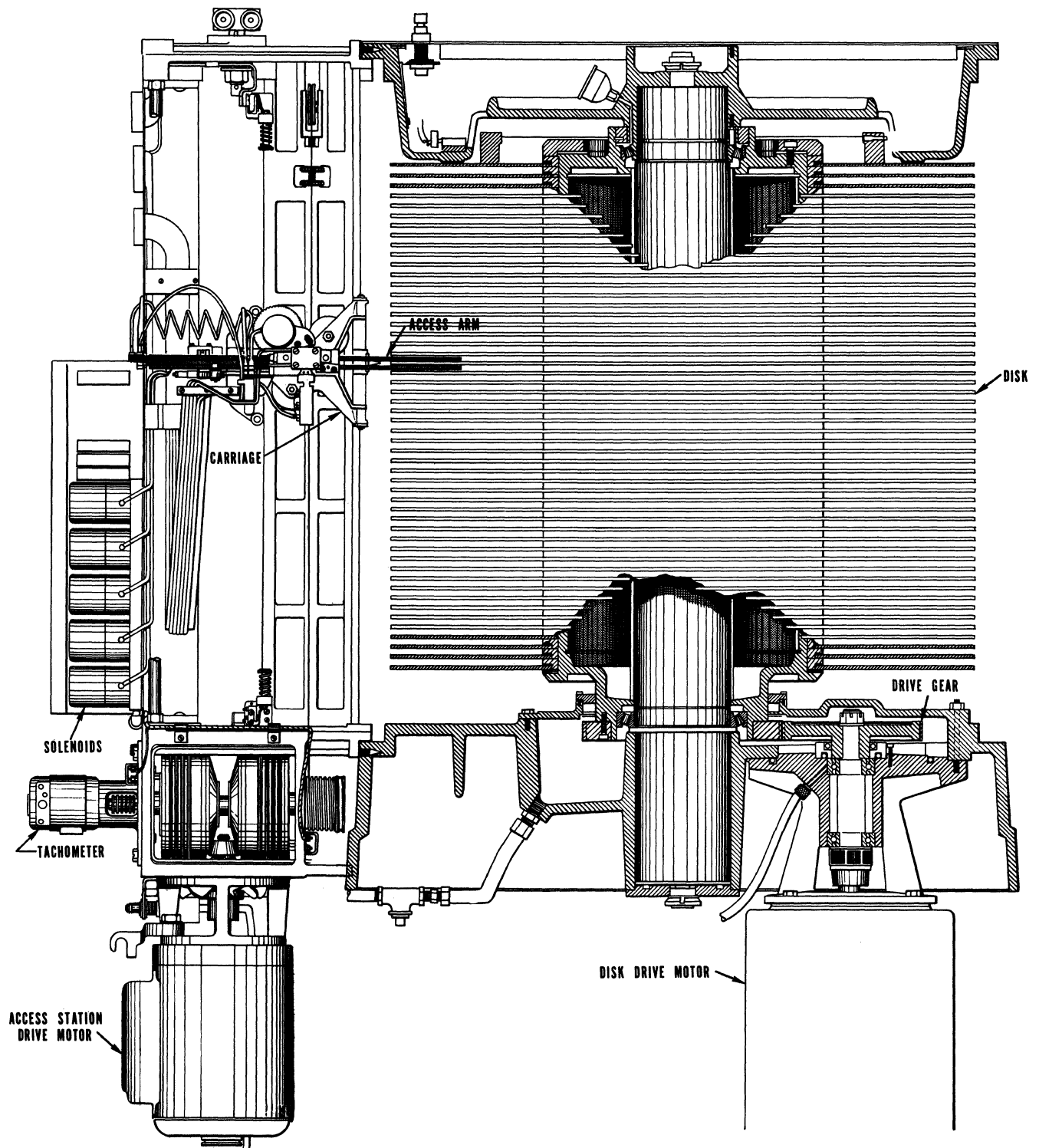


FIGURE 1-1. DISK STORAGE FILE AND ACCESS STATION

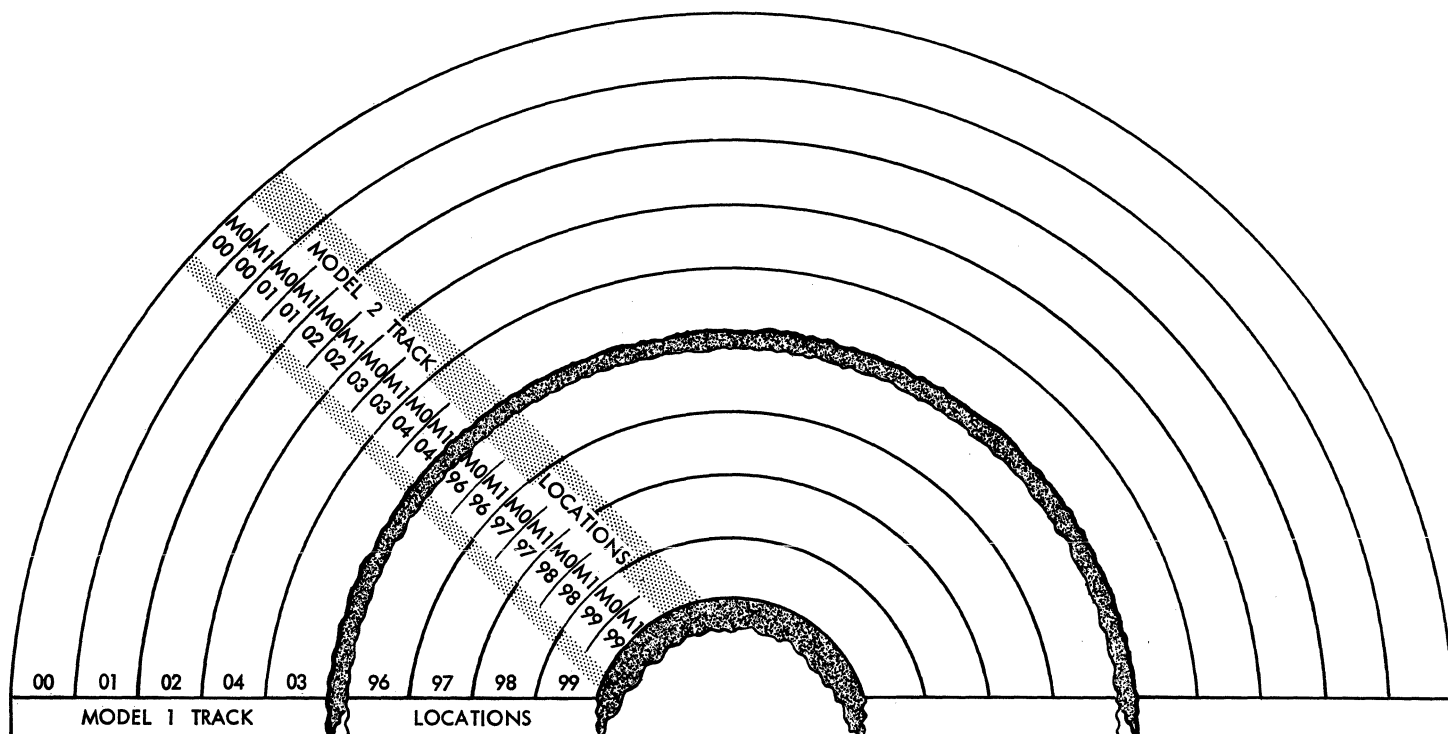


FIGURE 1-2. TRACK ARRANGEMENT

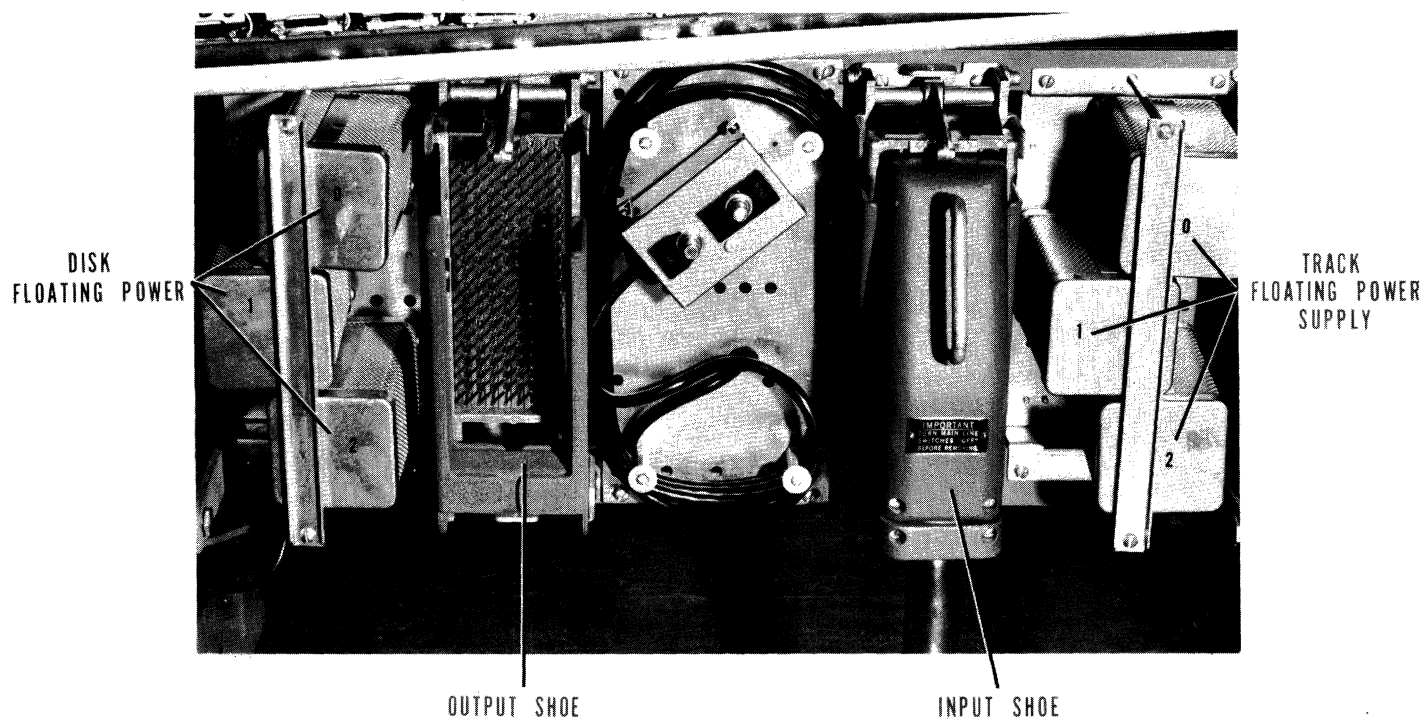


FIGURE 1-3. FLOATING POWER SUPPLY

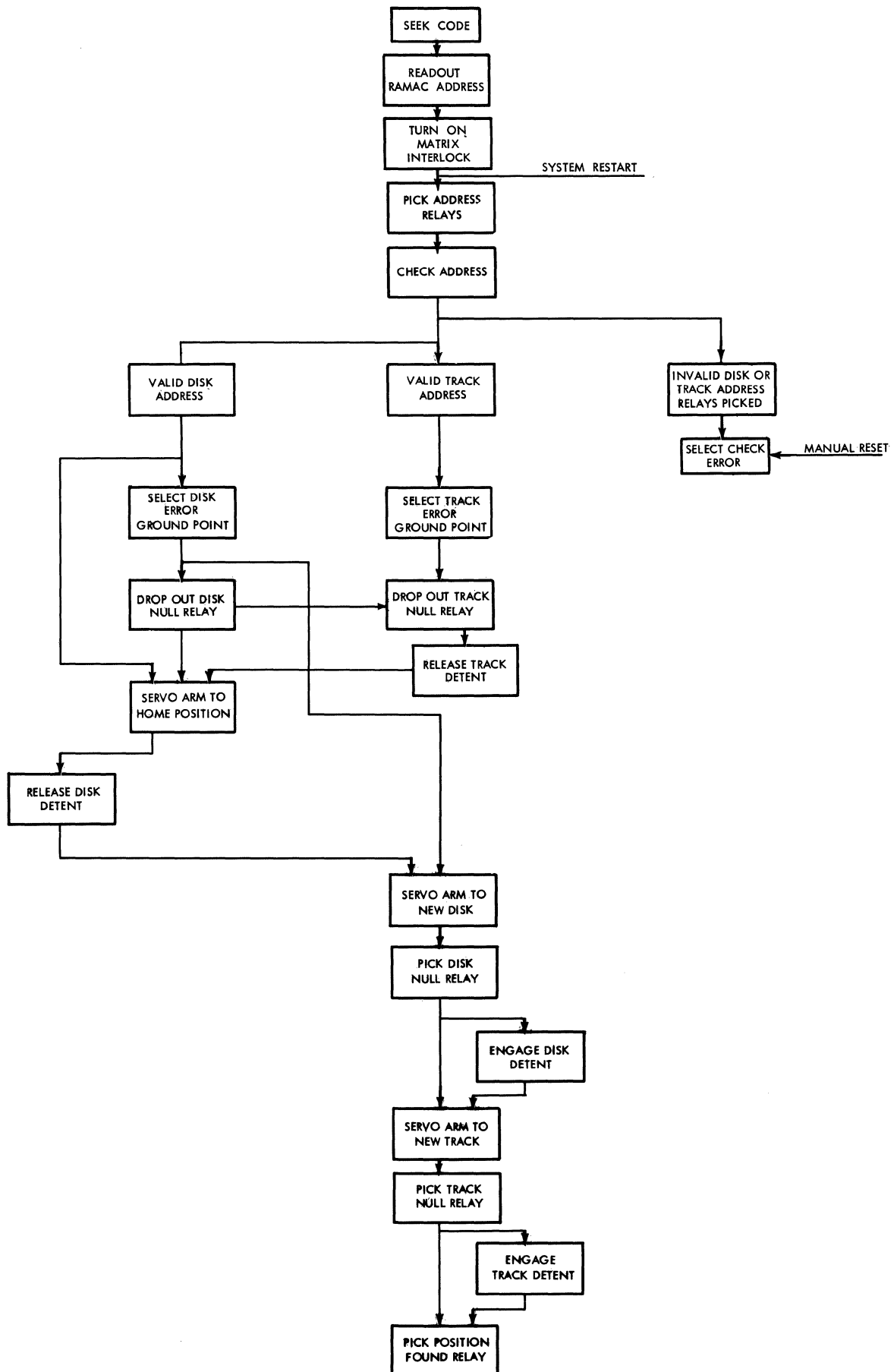


FIGURE 2-1. SEEK DISK STORAGE BLOCK DIAGRAM



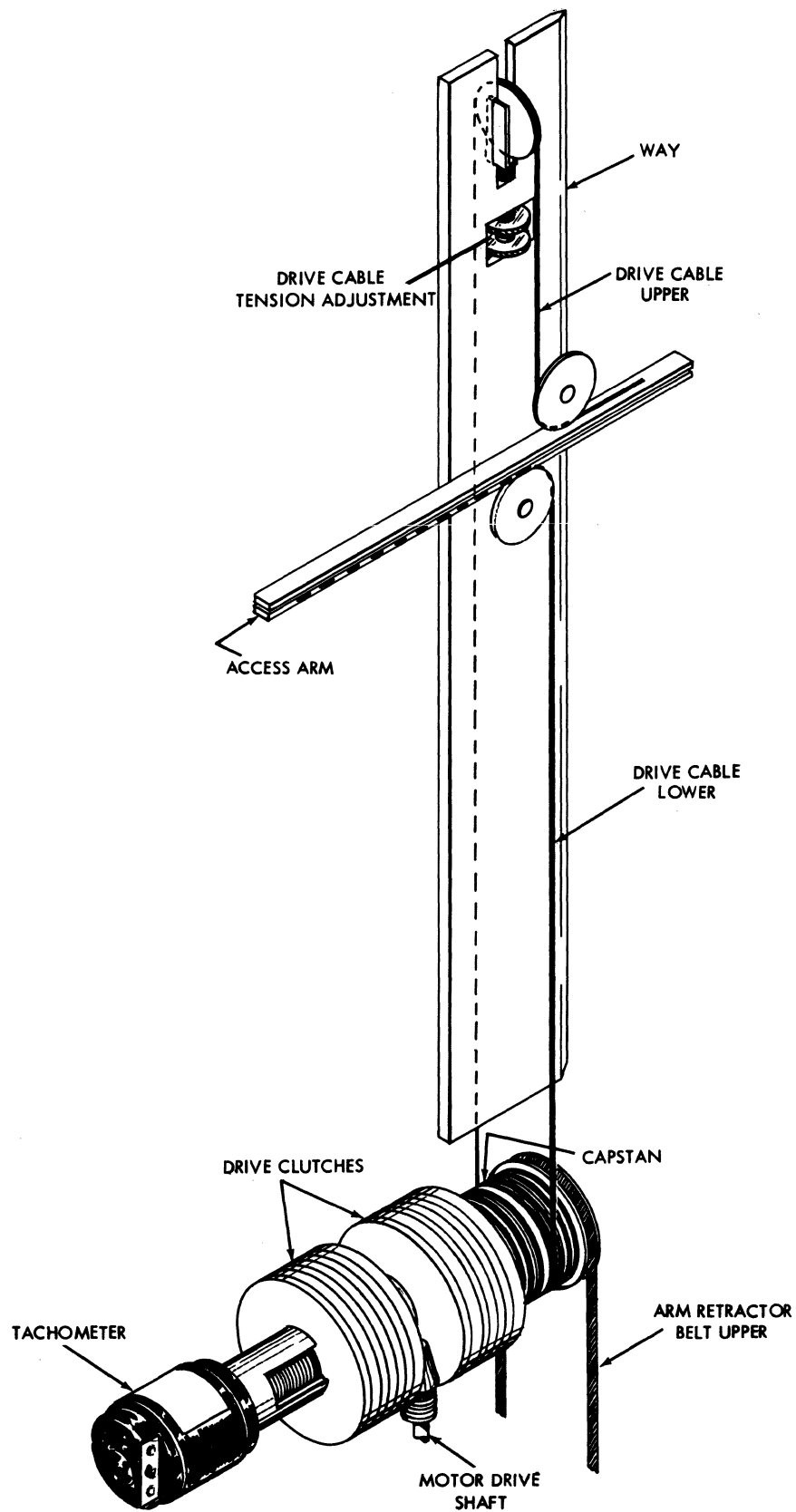


FIGURE 3-1. DRIVE CABLES AND TACHOMETER

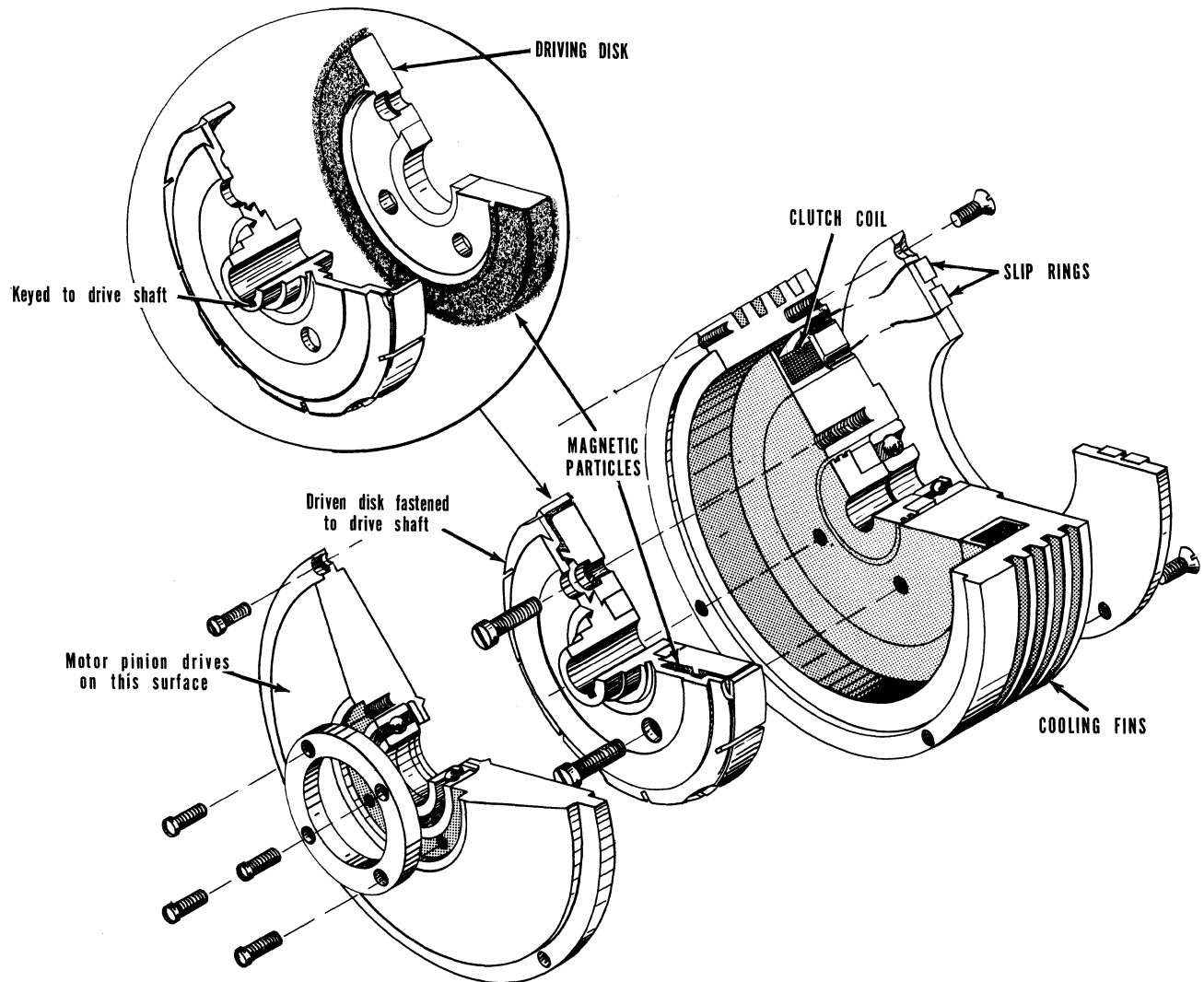
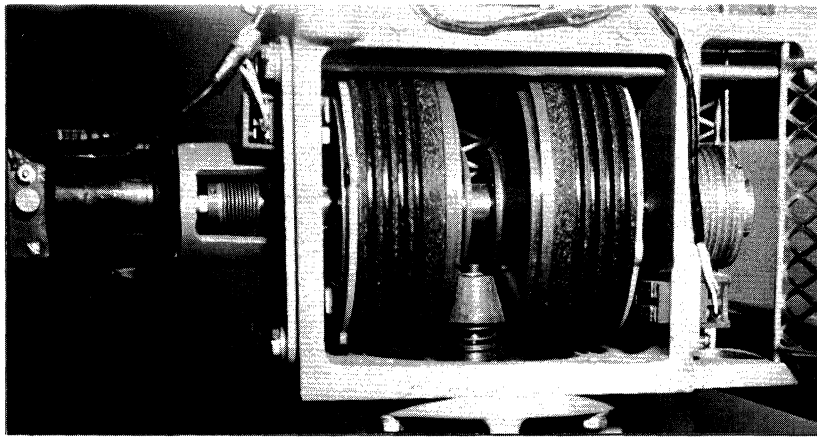


FIGURE 3-2. MAGNETIC CLUTCH

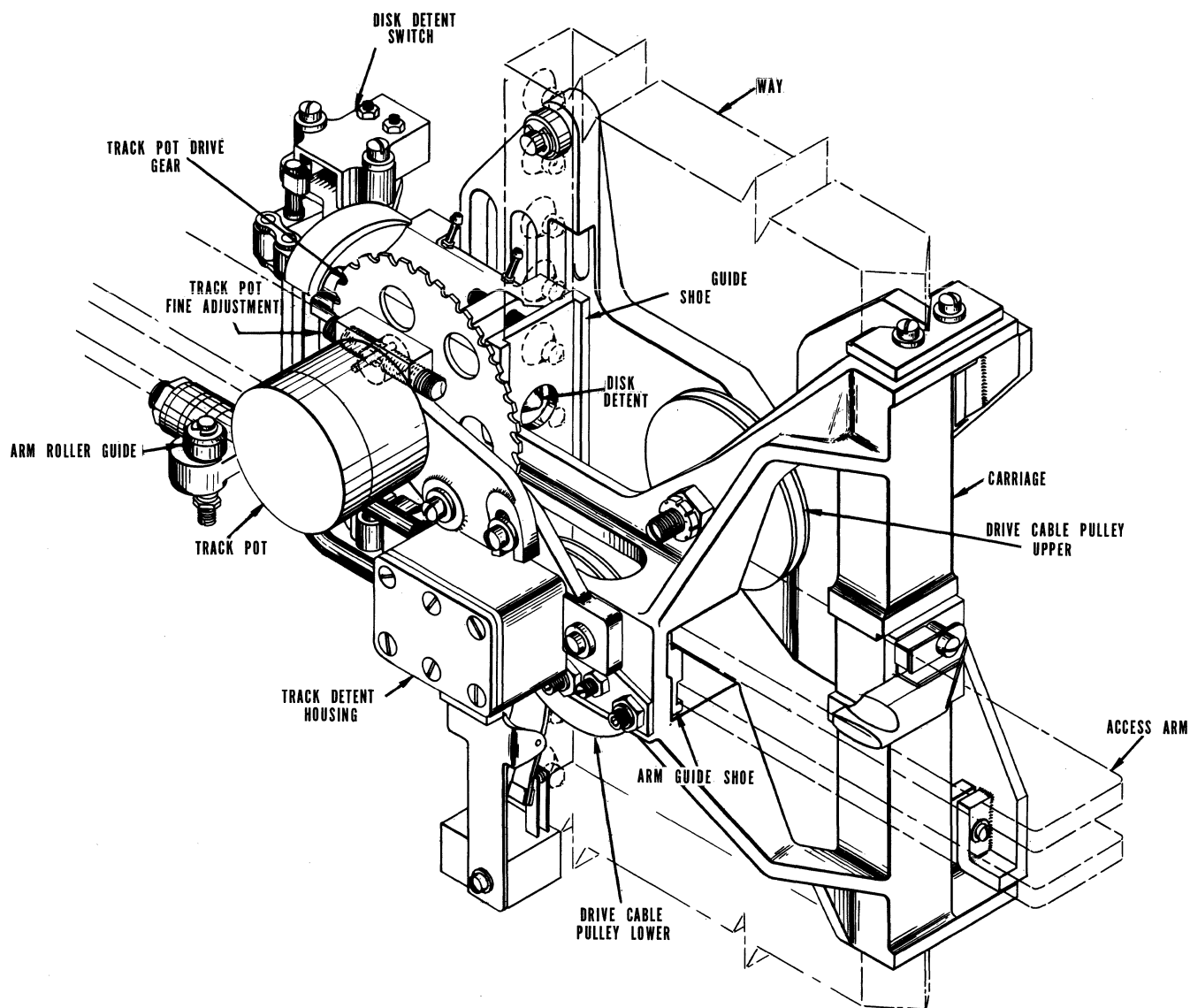


FIGURE 3-3. CARRIAGE

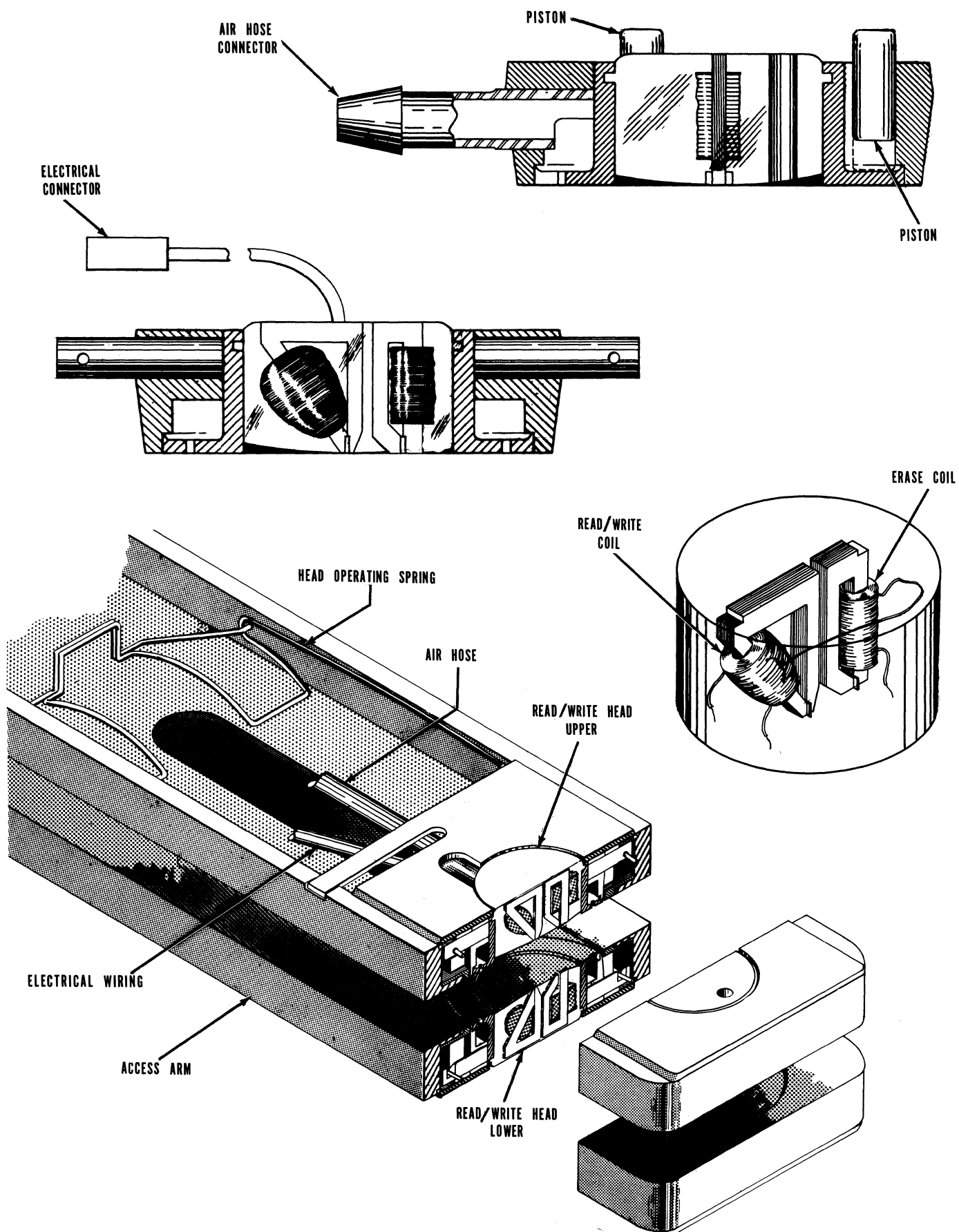
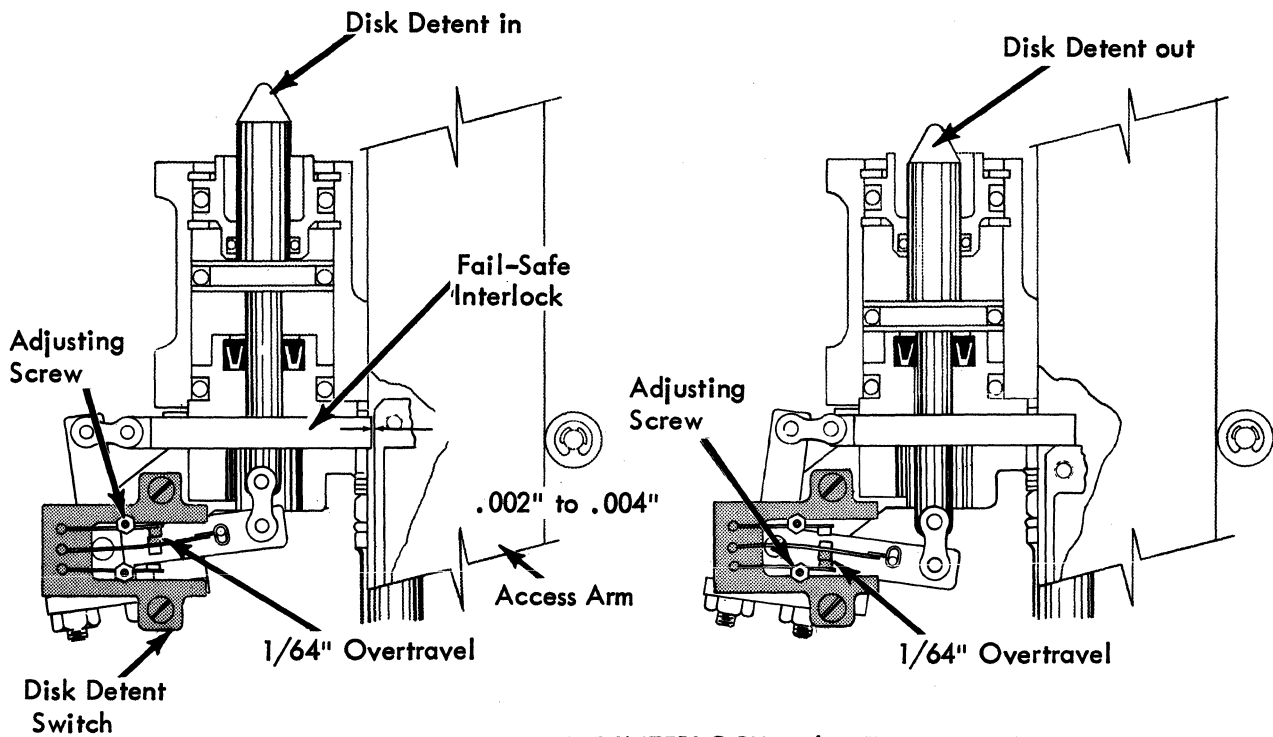


FIGURE 3-4. READ/WRITE HEADS



DISK DETENT INTERLOCK and DETENT SWITCH

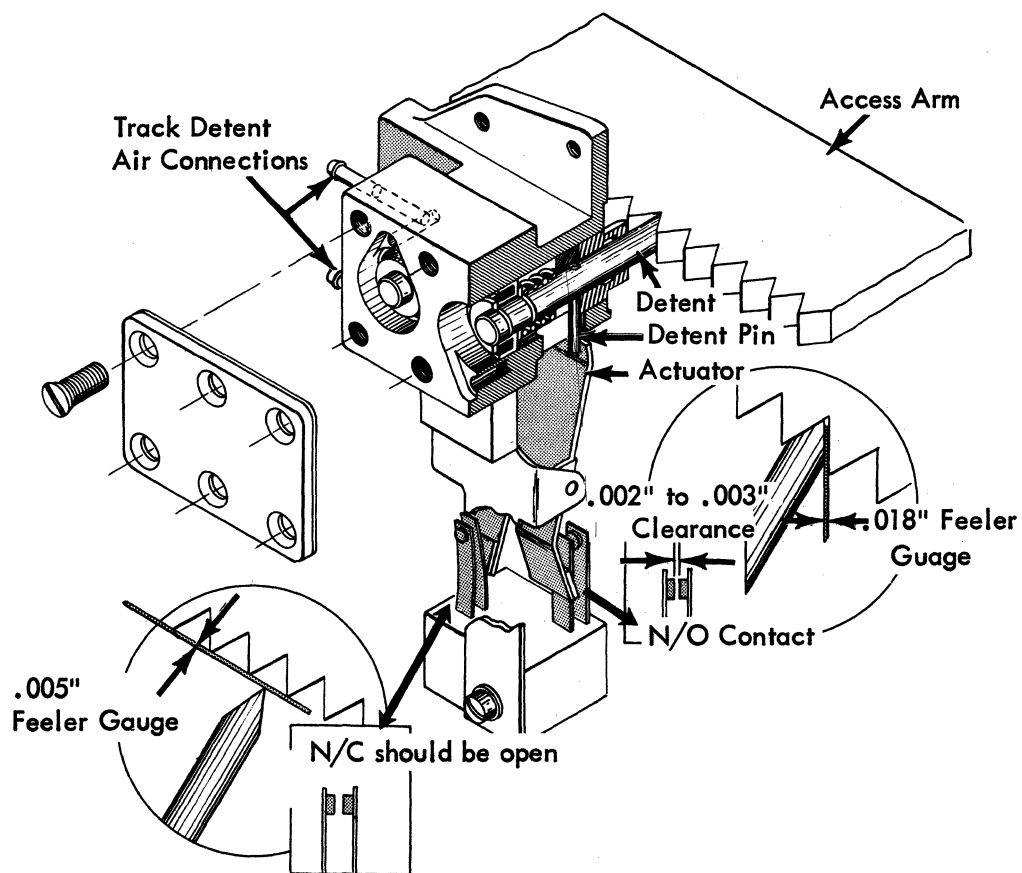


FIGURE 3-5. DETENTS

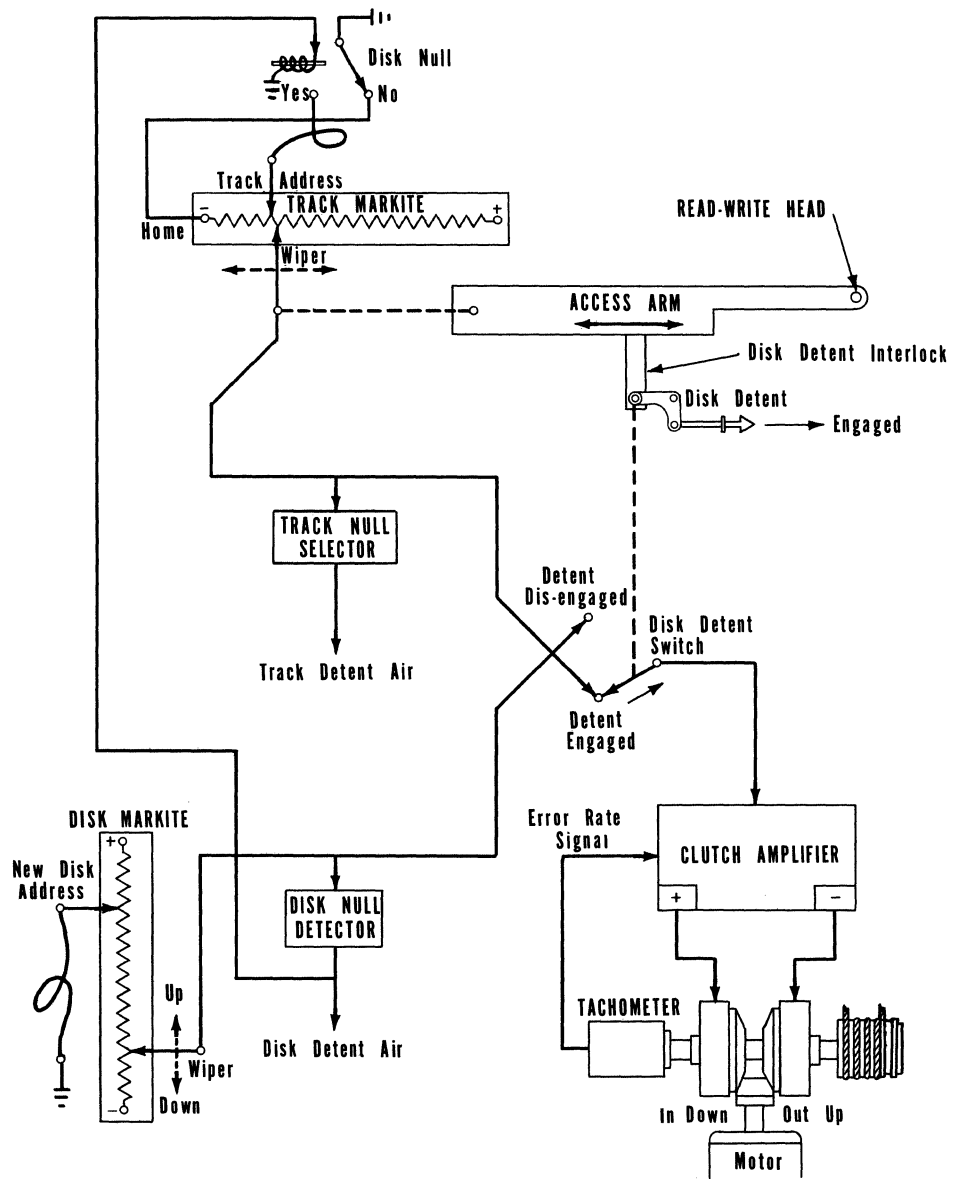
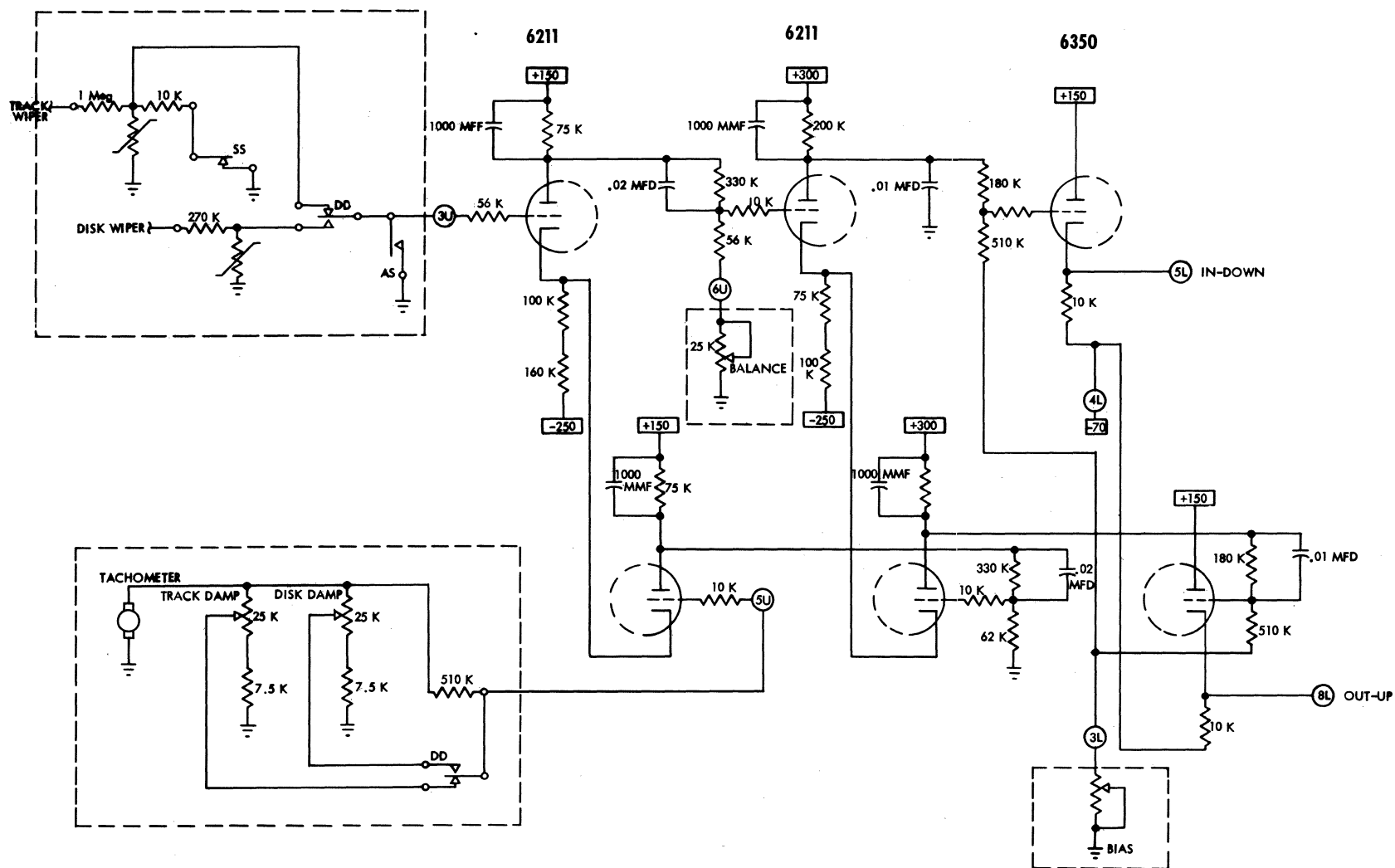


FIGURE 3-6. SERVO SYSTEM SCHEMATIC

FIGURE 3-7. SERVO CLUTCH AMPLIFIER



SC 505

IN 547

CF 567

IN 548

CF 568

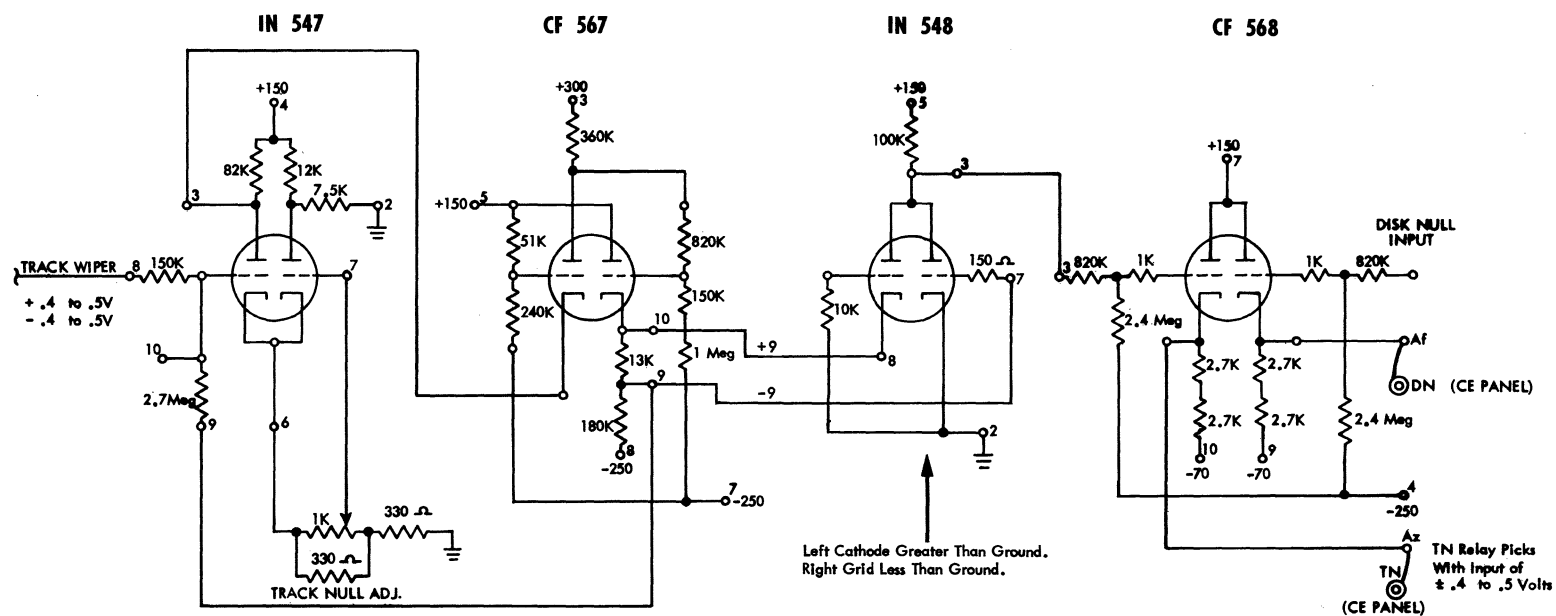
TRACK WIPER

TRACK NULL ADJ.

DISK NULL INPUT

TN Relay Picks With Input of  $\pm .4$  to  $.5$  Volts

Left Cathode Greater Than Ground. Right Grid Less Than Ground.





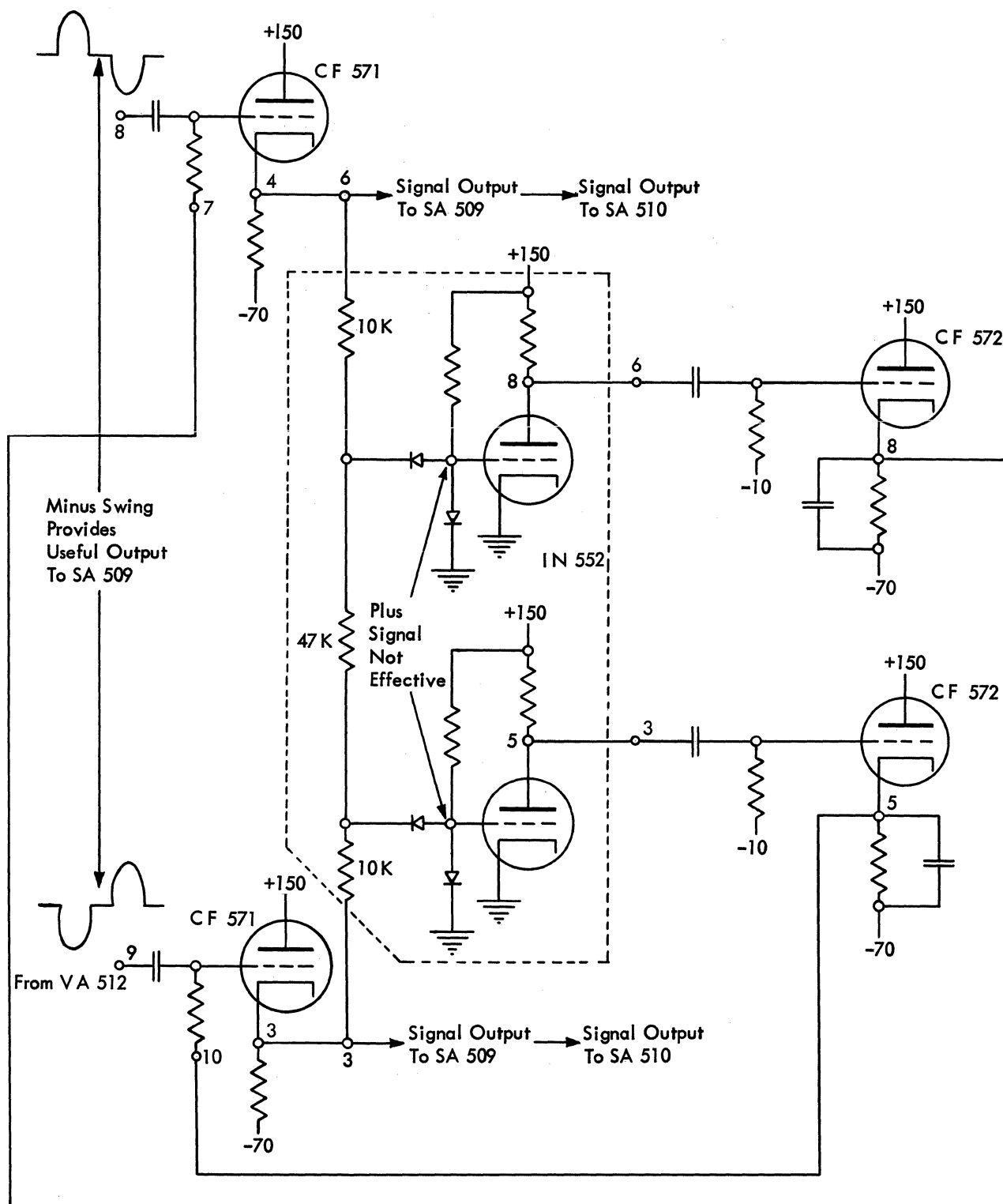


FIGURE 3-9. AUTOMATIC CLIPPING CONTROL

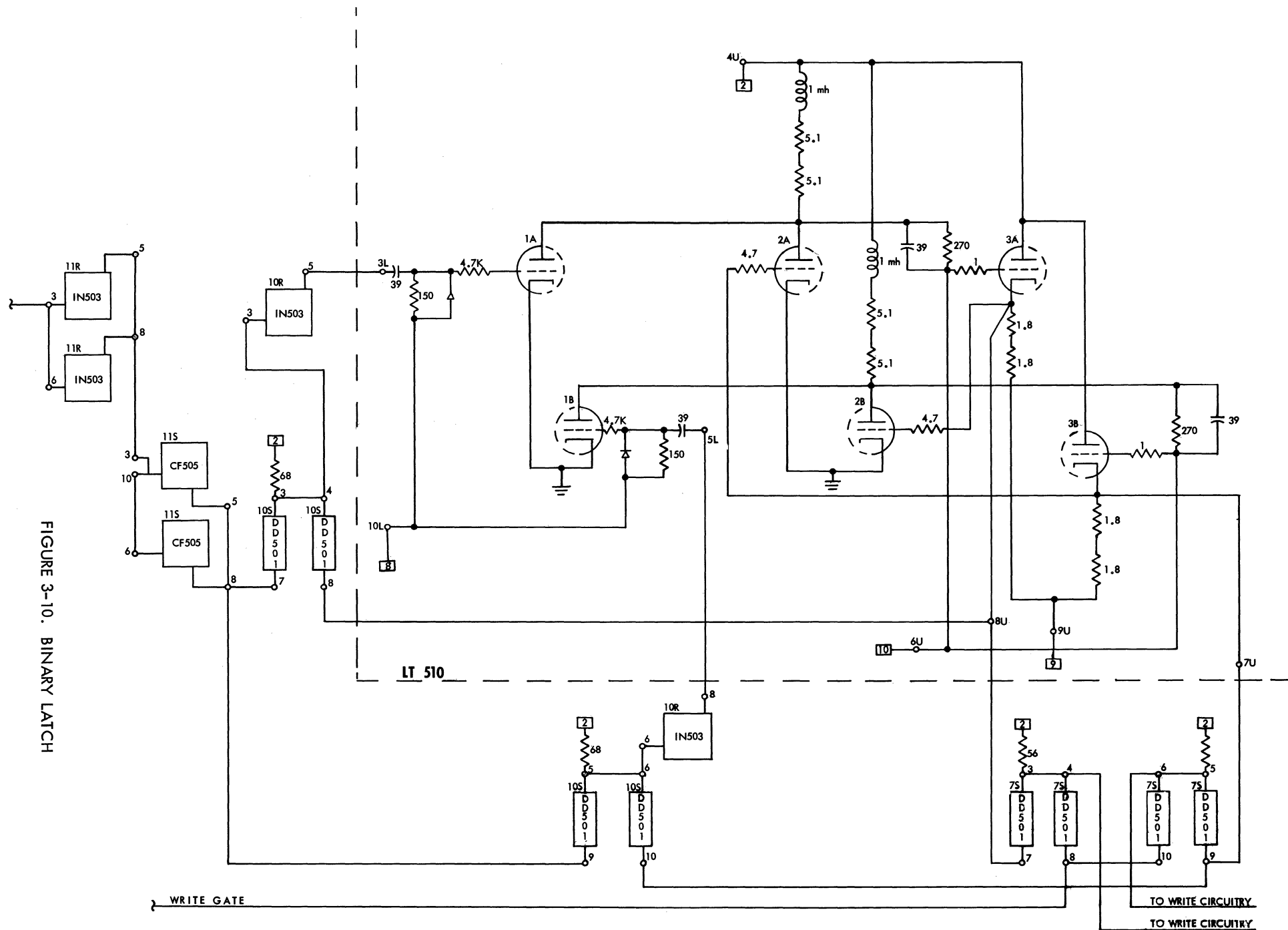


FIGURE 3-10. BINARY LATCH

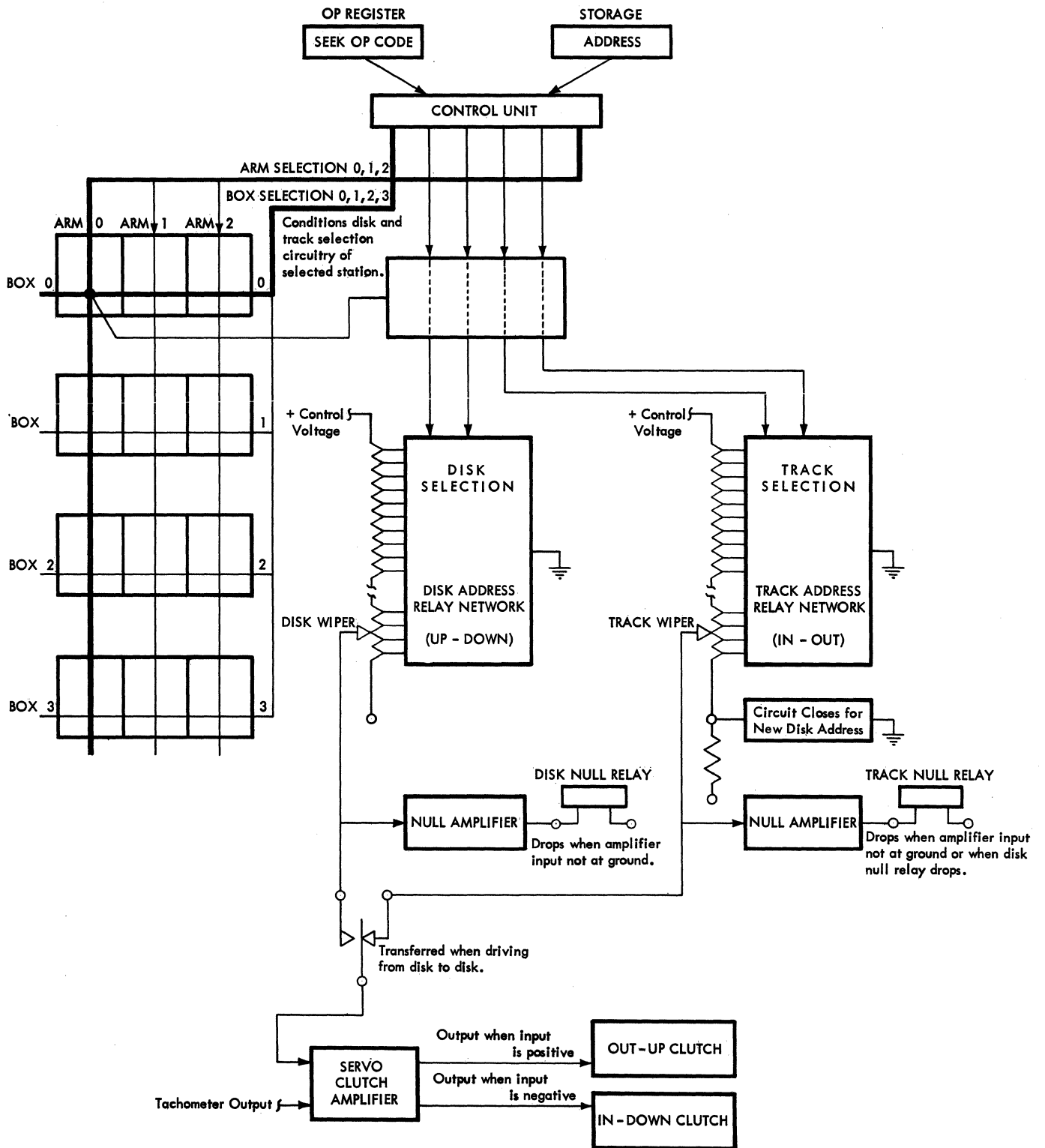


FIGURE 4-1. SEEK DISK STORAGE CIRCUIT SCHEMATIC

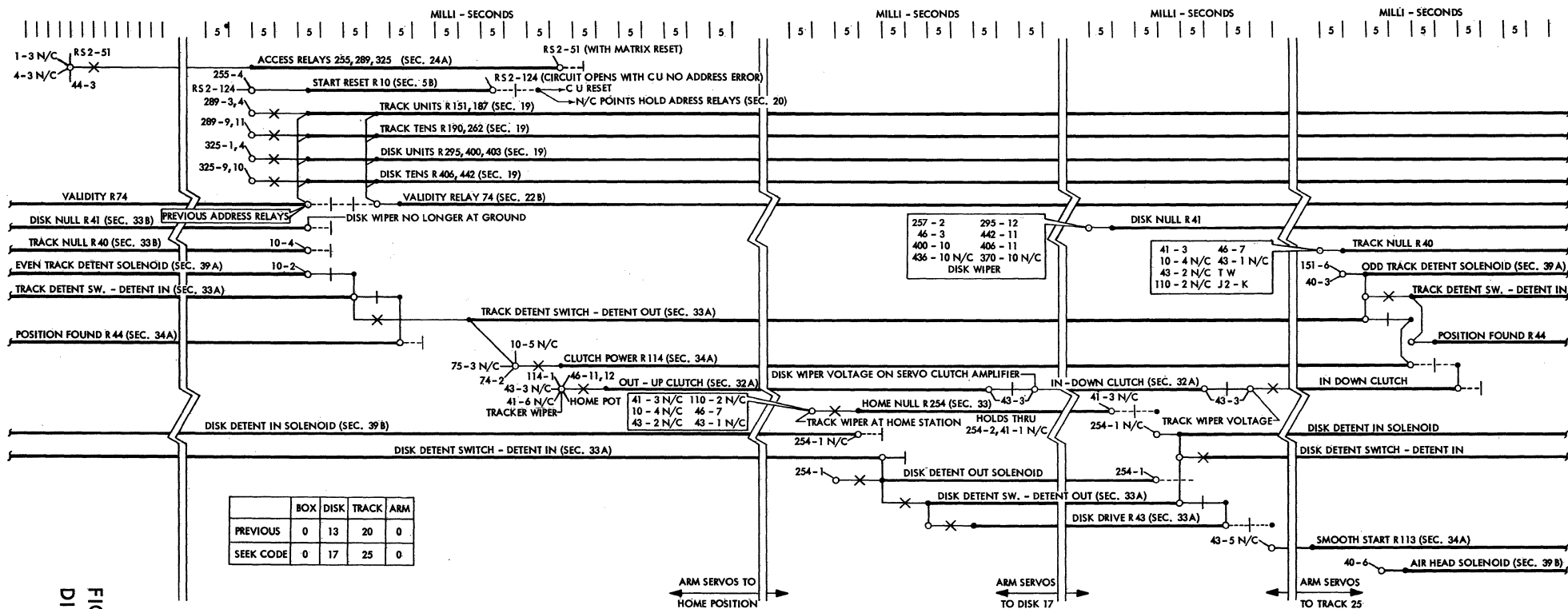


FIGURE 4-2. SEEK DISK  
DIAGNOSTIC CIRCUIT

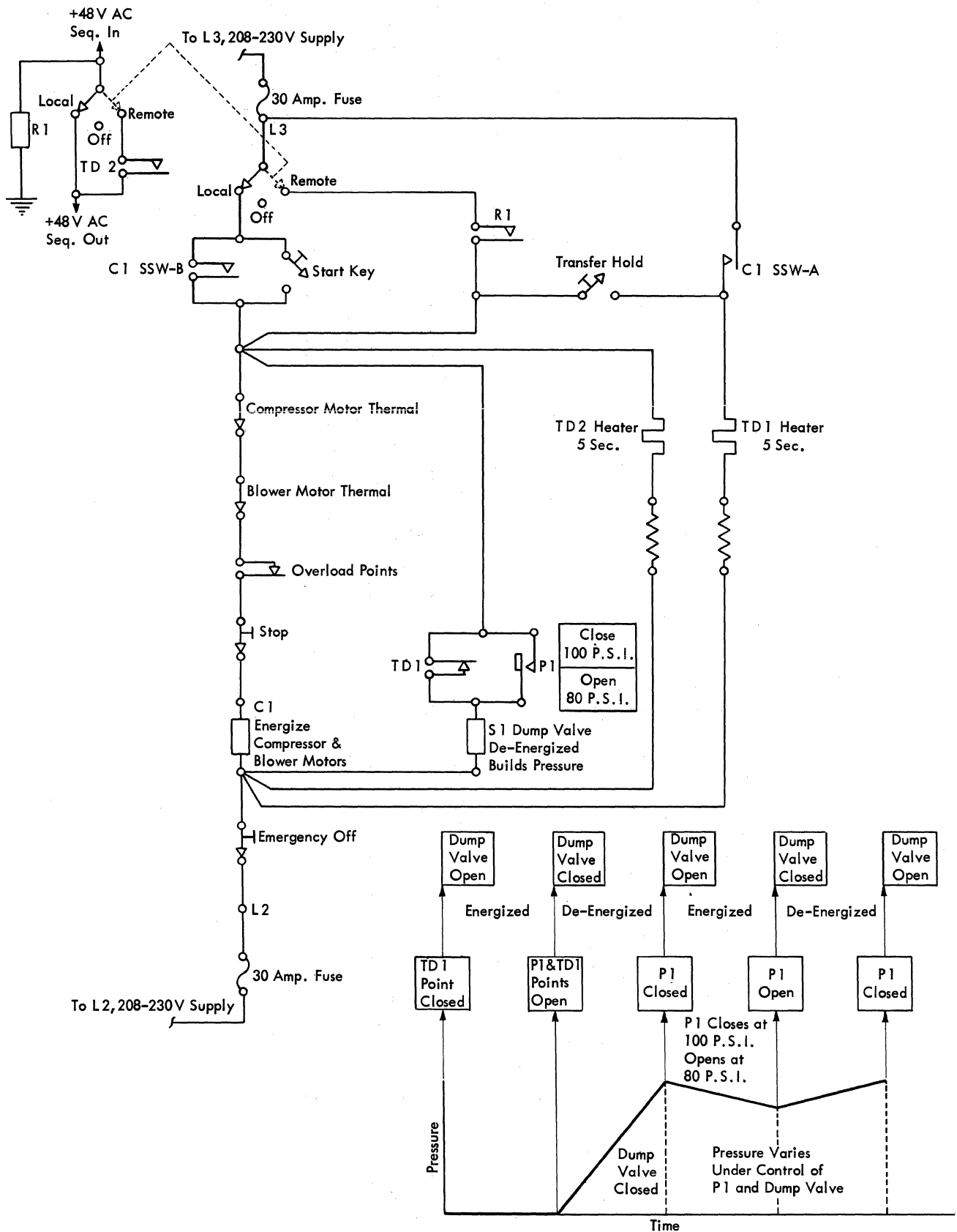


FIGURE 4-3. REMOTE COMPRESSOR CIRCUIT

